



Department for  
Business, Energy  
& Industrial Strategy

# SCIENCE AND INNOVATION AUDITS

Wave 1 Summary Reports



November 2016



## Foreword

This government is committed to an economy that works for all. We will develop an Industrial Strategy that will be long-lasting and deep-rooted, and which is essential to delivering our vision of a strong United Kingdom with a high wage, high productivity economy. It is also important that we recognise and take advantage of the differences that exist across the country. Helping the Midlands make the best of its future is as vital to a comprehensive national success as helping the South West or the North – but what is needed in each place is different, and our strategy must reflect that.

We need the best evidence and broad engagement. Economic growth does not exist in the abstract. It happens in particular places when a business is set up, or takes on more people, or expands its production. The Science and Innovation Audit (SIA) process has brought together business, universities, Local Enterprise Partnerships and other collaborators from across the private and public sectors to provide a key component of that evidence. This evidence is based not on a single point of view, but is the result of a shared endeavour by people and organisations involved in the frontline of research, innovation and business. It brings together national and international perspectives with the expertise of those working in the knowledge intensive areas upon which we will build our future economic success.

We know the UK's strength in world leading science and research. Our future success relies fully on engaging our world-beating science and research base with industry and local economies across the UK. Our most successful sectors, for example aerospace, automotive and life sciences, have worked in partnership with universities and Government support. We must learn from these successes so that other areas and sectors of existing and future strength can similarly benefit and these reports provide a clear indication of where we should start.

SIAs have produced not only important evidence, but they have also created new powerful relationships which are focussed on maximising these opportunities. These collaborations will be vital as we work in partnership with business, universities and civic leaders to deliver an economy that works for all, promoting a diverse range of sectors, and ensuring the benefits of growth are shared across cities and regions up and down the country.



A handwritten signature in black ink that reads "Joseph Johnson". The signature is written in a cursive, flowing style.

**Joseph Johnson**  
Minister of State for Universities, Science, Research  
and Innovation

# Introduction

The UK is a global leader in research and innovation. With 1% of the world's population, the UK produces 6.4% of all scientific publications – helping to create jobs, improve productivity and drive economic growth locally and nationally. To ensure the UK makes the most of these strengths, the government developed a process that brings together and supports local consortia of business, universities, research and innovation organizations, Local Enterprise Partnerships (LEPs) and their equivalents in the Devolved Administrations.

The Science and Innovation Audit (SIA) process will broaden and deepen our understanding of areas of potential globally competitive advantage across the UK. With independent analytical support, the consortia examine key science and innovation strengths in their regions to provide evidence of their potential to build and develop world-leading products, services and technologies.

The reports combine national data sets with an "on the ground" view based on local data, knowledge and experience. The analysis examines an area's strength in science and innovation and relates these to a national and international context. This evidence will help underpin future investment decisions, foster local collaboration and strengthen future bids for local investment from public and private sources.

This document collects together the summary reports from the five consortia who undertook the first SIAs:

- Edinburgh and the South East Scotland City region
- Greater Manchester and East Cheshire
- The Midlands Engine
- Sheffield City Region and Lancashire
- South West England and South East Wales

These consortia represent a range of approaches to scale, geography and sectors, and have tested the SIA process in these different scenarios. We have worked in partnership with consortia, and with analytical support from Technopolis, to develop the SIA methodology. This work will continue as we extend the process into waves 2 and 3 in order to create an evidence base that will inform future work locally, regionally and nationally.

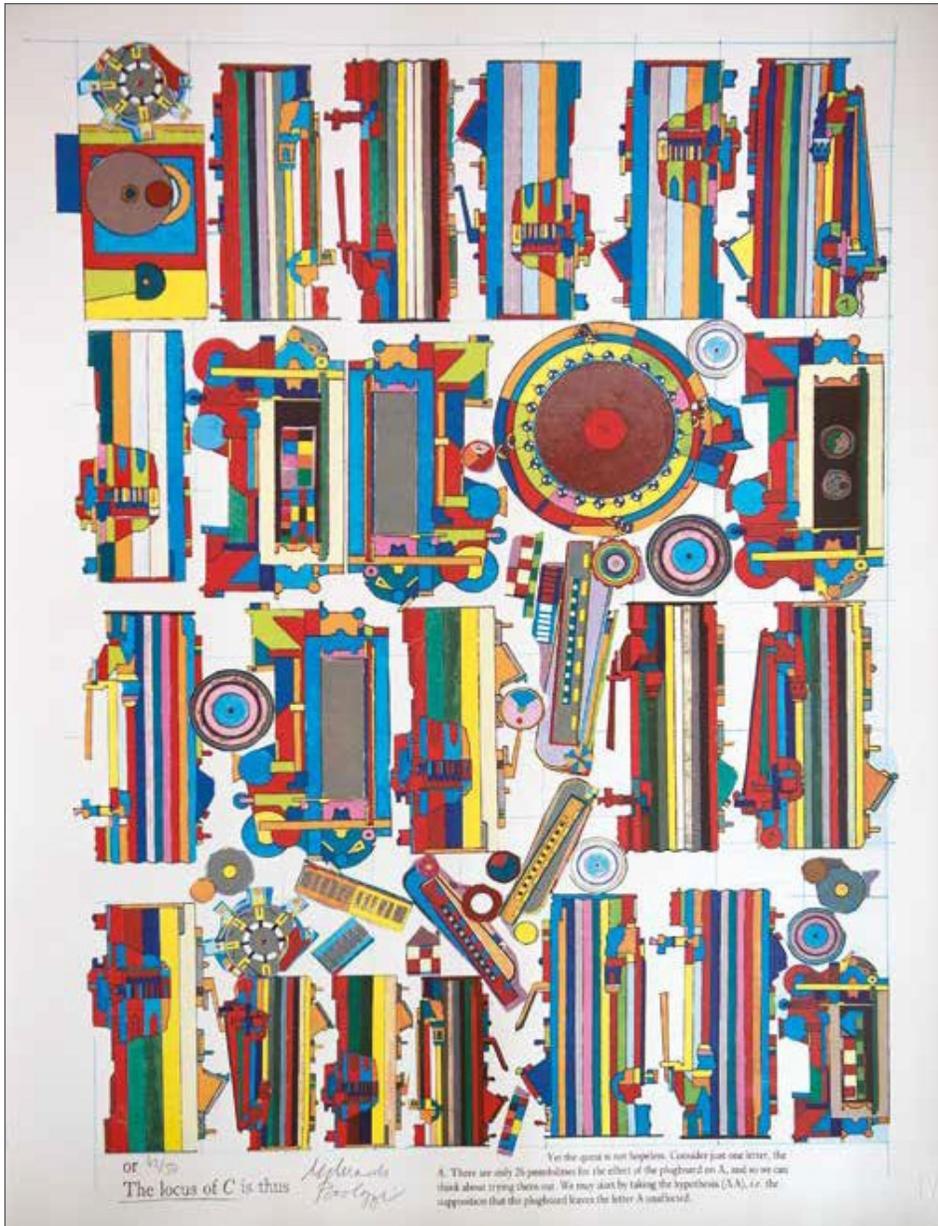
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## EDINBURGH & SOUTH EAST SCOTLAND CITY REGION

A Science and Innovation Audit Report sponsored by the Department for Business, Energy & Industrial Strategy - **Summary Report**



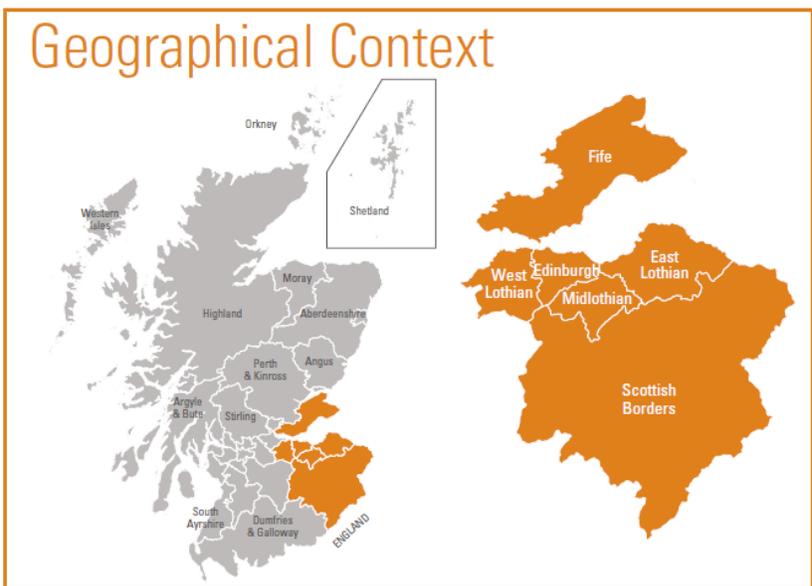
# Enabling a World-Leading Regional Digital Economy through Data Driven Innovation

## Introduction

We are now entering an era when the generation, collection, analysis and monetisation of huge volumes of data underpins the Digital Economy. The value of data comes from its use in real-time, or aggregation over long periods, to understand and predict behaviour. Whilst data has become ubiquitous, the challenges for all organisations are effectively to use this data to shape, develop and deliver innovative processes (including new digital products and services) to consumers and citizens. ***This is what we call Data Driven Innovation (DDI) and is the focus of our regional Science and Innovation Audit (SIA).***

## Economic Development Context

In Autumn 2015 the UK Government announced SIA to catalyse a new approach to regional economic development. In the Edinburgh and South East Scotland City Region (the City Region), we focused on our rapidly growing strength in Data-Driven Innovation (DDI). Here we summarise the key results from the SIA, including the challenges and the substantial opportunities for regional economic growth.



## Market Context

The digital and data economy is growing 2-3 times faster than the economy overall<sup>1</sup>. The Government's Shakespeare report (2013)<sup>2</sup> states that data and its manipulation lie at the heart of the next phase of the digital and data revolution. The importance of addressing critical shortages of digital and data skills has also been recognised by both Scottish and UK Governments<sup>3-8</sup>. Whilst the integration of digital within wider businesses is immature, in an open economy the only rational approach is early adoption and a commitment to benefit from these global forces. The primacy of investment in research, development, innovation and skills to improve productivity and economic growth is frequently highlighted<sup>9-10</sup>. Government reports call for action but stop short of providing specific proposals for investment. This SIA audited the digital and data science capabilities in the Edinburgh City Region. It provides clarity on our regional vision, the required investment priorities and the anticipated economic and societal benefits. We are poised to act to maximise the regional economy gains accruing from DDI.

## Data-Driven Innovation Strengths

We have audited DDI, a key driver of the digital economy, in the Edinburgh City Region and have identified globally-competitive strengths on which we can build:

- A strong base of already-digital and data-ready businesses, including 2 ‘unicorns’, and public sector organisations (e.g. 21,335 Digital Technology Economy Jobs in Edinburgh<sup>11</sup>)
- A strong base of talent & skills delivered by outstanding universities (e.g. 15,205 STEM students in region<sup>12</sup>)
- A strong base of scientific research and associated infrastructure, including key data assets
- A strong track record in innovation & entrepreneurship that has created a vibrant ecosystem.

### Case Study: Unicorn

Headquartered in Edinburgh, Skyscanner is a leading global travel planning and bookings site used by 50 million people per month. Founded in 2003, Skyscanner now employs over 800 staff and its products are now available in over 30 languages and 70 currencies<sup>13</sup>.

***"Skyscanner customers demand that we act locally. Our 400-strong Edinburgh team is, and will continue to be, a core hub for the company as we add data products for our consumers and the global flights industry."***

Alistair Hann, Technical Fellow



### Case Study: Unicorn

FanDuel is an online fantasy sports game and the largest daily fantasy sports company. Launched in 2009, FanDuel has raised \$363 million funding and now employs over 400 staff across 5 offices in Scotland and the US<sup>14</sup>.

***"The birth and explosive growth of FanDuel would not have been possible without early-stage support from the University of Edinburgh, Scottish Enterprise and Pentech Ventures coupled with the wealth of tech talent available in Scotland. We have recently launched our first ever product outside of North America - one-day fantasy football here in the UK and are continuing to develop our offerings and scale the business."***

Lesley Eccles, Co-Founder



## Growth Opportunities

The ubiquitous and disruptive nature of DDI within the digital economy offers substantial opportunities for cross-sectoral GVA growth. We can achieve improved competitiveness by harnessing data and technology skills more effectively to increase productivity, “taking the handbrake off” our digital sector and boosting jobs. Examples include increasing the regional share of the growing Fintech marketplace, growing more global services companies from start-up to “Unicorns”, and re-inventing processes for delivery of public sector services such as healthcare, transportation, civil infrastructure and Local Authority administration.

These opportunities are all enabled by focusing on the practical application of DDI across the economy to harness the increased productivity of a much broader data-savvy workforce. This will enable the delivery of transformational data-driven services with a high digital content. By addressing a wider workforce we can tackle the political, social, and human factors that have inhibited productivity growth. The opportunity for impact is robust and inclusive, embracing:

- providers and consumers of services, including customers and citizens
- all sectors of the economy (private, public and third)
- all scales of the economy, from start-ups to large corporates to Government. A key priority is continued investment in entrepreneurship activities to create and scale new companies, and align new services into the supply chains of existing large corporations and Government
- a wide range of key regional industries including creative/digital, financial and business services, life sciences, healthcare, tourism, energy and higher education.

### Case Study: Global Technology Company

Founded in 2004, Amazon's 110-strong development centre in Edinburgh is part of a global team that invents and develops innovative products and solutions for Amazon's customers around the world.

World class data scientists are at the heart of the solutions Amazon's team develops, using its unique datasets to provide the best products and services to its customers<sup>15</sup>.

*"The unique skillset of our Edinburgh team contributes hugely to Amazon's ability to support its customers around the world. Our Edinburgh development centre reflects the world-class data science capability and talented individuals that live and work here. The quality of life offered in*

*Scotland's capital city enables us to attract top talent from around the world, so that we can offer Silicon Valley jobs here in the heart of Edinburgh."*

*Graeme Smith, Managing Director,  
Amazon Development  
Centre (Scotland)*



### Case Study: Global Technology Company

As part of a strategic data science partnership with the Alan Turing Institute, Intel has established a processor design team in Edinburgh to feed new algorithms developed by the Institute into the design of future microprocessors<sup>16</sup>.

*"By establishing a team in Edinburgh, and collaborating with the Turing Institute, we will be able to access to ground-breaking technology insights that will power future product designs."*

*Rod O'Shea. Intel EMEA*

*Sales & Marketing Director*



## Our Vision for 2025-35

By 2025, the Edinburgh City Region will be home to a digital cluster that is the best in Europe in terms of its size and dynamism. It will be a location of choice for organisations that power services through data science, exceeding London, Berlin and Paris. Digital will touch everyone. The City Region will have taken a lead in embracing the opportunities of data driven innovation throughout the economy, in public, private and third sectors.

Through a regional partnership we will:

- Make the City Region a global destination of choice for organisations that power services through the application of data science
- Create a trusted public-private-third sector partnership that will have secured £500 million of investment and unlocked economic opportunities worth in excess of £5 billion<sup>17</sup>, delivering 50,000 new jobs and a further 50,000 up-skilled jobs
- Deliver transformational efficiency gains across the public sector
- Exemplify a strategy for UK regional growth and data-driven societal prosperity.

In October 2015, the Organisation for Economic Co-operation and Development (OECD) published a report<sup>18</sup> on data-driven innovation which found “that countries could be getting much more out of data analytics in terms of economic and social gains if governments did more to encourage investment in Big Data and promote data sharing and reuse”. These themes resonate strongly with our City Region’s vision for 2025-35.

## Gap Analysis

SITUATION	2025-35 AMBITION	GAPS & PRIORITIES
Regional growth strategy performing relatively poorly against UK and Europe with regard to productivity	A cohesive exemplar for UK regional growth and data-driven societal prosperity	<b>Adoption</b> Broad DDI adoption across the private and public sectors to take the brakes off regional growth
Growing UK digital cluster is limited by talent, access to data & investment	Global location of choice for DDI companies - powering regional growth and attracting investment from the UK and internationally	<b>Research</b> A globally competitive DDI talent pool trained in using high quality, diverse datasets and leveraging our world-class research
Data sharing is confined to specific sectors limiting levels of innovation and value realisation	Data sharing and re-use is ubiquitous within strong data governance models	<b>Datasets</b> Universal data sharing agreements within well-defined ethical and practical standards
Fragmented entrepreneurship activities receiving limited investments	Trusted cross-sector partnership investing in DDI at scale to drive innovation and entrepreneurship	<b>Entrepreneurship</b> A Regional Data Science Innovation Cluster implementing a coherent entrepreneurship
Public sector under extreme fiscal pressure and not realising efficiency gains	Public sector transformed through delivery of high efficiency DDI services	<b>Talent</b> Open Datasets and increased pool of talent & expertise to leverage service innovation within our major public sector

### Case Study: Aspiring Technology Company

Edinburgh-based Brainn Wave is a new start-up company aiming to provide a world-class data and services marketplace (Brainnwave) to customers and researchers seeking specific, up to the minute, high-value open and commercial data in specialist domains (e.g., energy, security, geospatial etc.)<sup>19</sup>.

***"Our technology is built using leading edge research. This is not something we could have afforded on our own as a start-up.***

***Scotland has built strong cross over ties between business and academia. We established our research team in Edinburgh as a result of the ease of doing business and engaging with our academic partners at the University of Edinburgh and the University of Glasgow. This has enabled us to accelerate our technology research and build upon state of the art science that has been built in research labs. This gives start-ups like Brainnwave the opportunity to have the equivalent research scale of any global company without the overhead cost."***

Steve Coates, CEO



### Case Study: Aspiring Technology Company

Quorate is a spin-out from the Centre for Speech Technology Research at Edinburgh University. Quorate has developed a highly adaptable Automatic Speech Recognition platform which is targeted towards natural-styles speech. By training acoustic models on hundreds of hours of audio and language models on many billions of words, the system can be optimised for different domains and applications<sup>20</sup>.

***"Quorate continue to maintain close ties into the informatics research community. These relationships not only provide us with visibility over the latest potential advancements in our field, they also offer academics a powerful insight into the real-world problems that we solve for our customers in the financial services, media and aerospace sectors."***

Nick Rankin, CEO



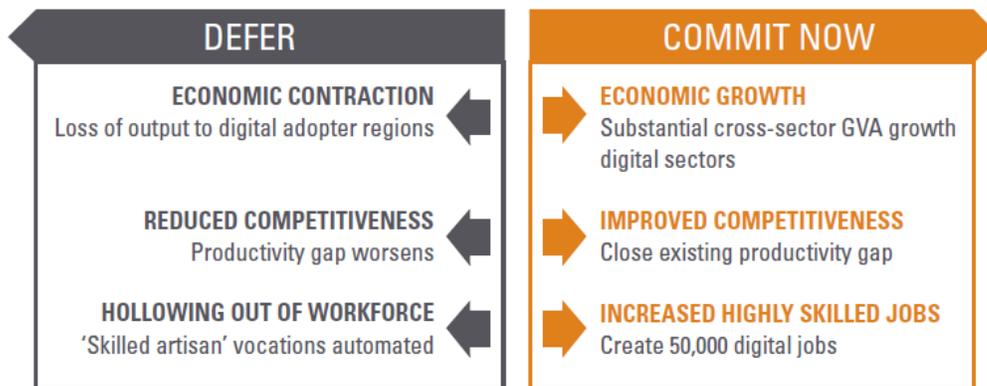
## Networking and Collaboration

Our Consortium comprised all regional representative elements including Higher Education Institutions (led by the University of Edinburgh), local innovation organisations (The Data Lab, Interface), Scottish Enterprise, Local Authorities (led by the City of Edinburgh Council), Scotland IS (the trade body for digital ICT in Scotland) and business. The broad spectrum of networking and collaboration with business has been exemplified by the preceding six case studies. The SIA has already increased interactions between these partners. Specifically it has:

- catalysed deeper engagement between the Universities, industry and public sector partners around DDI and related themes such as innovation hubs, low carbon and Internet of Things networks.
- increased the intensity of collaboration within the University of Edinburgh, stimulating diverse multidisciplinary working across academic boundaries.
- supported implementation of a new operating model in which the University is more accessible, highly networked and open to a range of collaboration models with private and public sector partners that have spawned numerous high level company interactions. In turn, these have surfaced common interests between companies enabling the SIA team to broker new business-business contacts
- benefited from the existing networks and collaborations in two of our key DDI assets: the MRC Farr Institute in Scotland and the ESRC Administrative Data Research Centre (ADRC). The Farr is a collaboration between 6 Universities and NHS Scotland, working closely within a national Farr network in Wales, Manchester and London to create a UK network for data science and innovation in health and social care. ADRC Scotland promotes research on routinely collected administrative data (including geographical, social, economic, educational and governmental), bringing together social scientists and data scientists from 7 Universities with statisticians from Government organisations. Crucially, the Farr and ADRC have proven the efficacy of the model proposed in the SIA combining physical and e-infrastructure to facilitate collaboration whilst ensuring the trustworthy use of data.
- initiated engagement with student leaders who have responded positively to the new opportunities.
- strengthened relationships with Scotland IS and built new interactions, particularly in Fintech through Scottish Financial Enterprise (the trade body for Financial Services). We anticipate these new interactions, catalysed by the SIA, will endure.
- re-invigorated discussions with Scottish Enterprise.

## The Tipping Point

The SIA leads to clear conclusions. The City Region is already a powerhouse of DDI activity. It is a significant cluster in the UK and is growing fast. However, this growth is at a tipping point. Without targeted investment the growth will stall. Investments made now will enable us to harness the disruptive potential of data science at which we already excel. However, the exact scope, scale and timing of these impacts remains unclear. The question we face is simple; is now the right time to commit fully to the DDI opportunity? We have provided evidence that we must take concerted actions so that the City Region will benefit from the disruptive effects of DDI. If investment is deferred, we run the risk of losing both competitiveness and output to other digital clusters that have the confidence to invest. We also risk losing jobs in myriad parts of the economy as a result of automation extending into knowledge-intensive services. We recommend action now to mitigate these risks and fully realise the region's substantial potential.



## Proposal

The SIA demonstrates a compelling business case for Regional transformation that will deliver tangible progress as soon as we can secure the necessary investment. Moving forward rapidly we propose to create a disruptive regional ecosystem that *unlocks value from public data and delivers sustainable gains in private sector activity, public sector transformation and digital skills*. We will do this through investment in a **Regional Data Science Innovation Cluster** comprising three closely-linked nodes which will bring together over 5,000 people from business, the public sector, academia and the community. With investment in this cluster we will harness our trusted existing partnerships across the public sector to create the foundation for a unique data-driven regional economy operating at a significant scale. Beyond the immediate opportunities for public sector efficiencies and reform, this will afford a substantial opportunity for industry to build on the already impressive technology cluster in the Edinburgh City Region. Specifically, we propose:

1. Stimulate innovation and entrepreneurship in the City Region by creating sector- focused open innovation locations bringing together industry, the public sector, students and academia in collaborative environments all underpinned by data and access to digital technologies. Partnership models will include business-to-business, business-to-public sector and business-to-academia, as well as creating opportunities for public sector ownership in private data-driven innovation companies and open innovation competitions.

2. Create value chains from sensors to data assets to research prototypes to new products and services.
3. Rapidly build a data-skilled workforce to support the growth and scaling up of the digital economy and regional private sector cluster. Our ambition is for every university student and suitable graduate in the regional workforce to be offered a “hands-on” data science or digital content course appropriate to their occupational ambition.
4. Facilitate collation, integration, analysis and interpretation of high volumes of regional data across a range of sectors, where previous cross-sector analysis has been disjointed or non-existent. Improved access to public sector data will enable better- informed policy decisions, and help Government to understand how to optimise the use of big data. Suitably governanced, it will also offer a substrate for private sector innovation and growth.
5. Harness the University of Edinburgh’s expertise in social science to develop a trusted social compact through public engagement and community involvement on the ethical use of data. The University is a global leader in this domain, having already developed a trusted “safe haven” where NHS, social science, research and government datasets are integrated for discovery and innovation.



## References

- <sup>1</sup> Tech City UK, Nesta ‘Tech Nation 2016’, February 2016
- <sup>2</sup> Shakespeare Review ‘An Independent Review of Public Sector Information’, May 2013
- <sup>3</sup> Scottish Government Data Management Board ‘A Data Vision for Scotland’, April 2014
- <sup>4</sup> House of Commons ‘The Digital Economy’, Second Report of Session 2016–17, July 2016
- <sup>5</sup> House of Lords ‘Make or Break: The UK’s Digital Future’, February 2015
- <sup>6</sup> Scotland’s Digital Future: A Strategy for Scotland, The Scottish Government 2011
- <sup>7</sup> Digital Skills Crisis House of Commons Science & Technology Committee Second Report of Session 2016–17
- <sup>8</sup> House of Commons Science and Technology Committee The Big Data Dilemma Fourth Report of Session 2015–16
- <sup>9</sup> SIA: Call for Expressions of Interest
- <sup>10</sup> Encouraging a British Invention Revolution: Sir Andrew Witty’s Review of Universities and Growth
- <sup>11</sup> Tech City UK, Nesta ‘Tech Nation 2016’, February 2016
- <sup>12</sup> HESA HE Students 14/15 academic year in Physical, Mathematical and Computer sciences and Engineering & technology
- <sup>13</sup> Information provided by company. <https://www.skyscanner.net/>
- <sup>14</sup> Information provided by company. <https://www.fanduel.co.uk/>
- <sup>15</sup> Information provided by company. <http://www.amazondc.com/>
- <sup>16</sup> Information provided by company. <http://www.intel.co.uk/content/www/uk/en/homepage.html>
- <sup>17</sup> Economic analysis undertaken by BiGGAR Economics
- <sup>18</sup> OECD ‘Data-Driven Innovation: Big Data for Growth and Well-Being’, October 2015
- <sup>19</sup> Information provided by company. <http://brainwave.com/home>
- <sup>20</sup> Information provided by company. <http://quoratetechnology.com/>

The cover image is from the Turing Suite by Sir Eduardo Paolozzi (1924-2005), one of the most versatile artists from Britain after 1945. Educated mainly in London and Paris, he always had strong ties to his hometown Edinburgh.

Alan Turing was an informatician who, in the 1930s, worked on the theory that brains are computational devices. He developed the Universal Turing Machine, helping fix the limits of mechanical computation; modern computers directly descend from his ideas. As well as being a key figure during the Second World War at Bletchley Park, Britain’s code breaking centre, Turing is also considered the father of artificial intelligence, and the first computational biologist.

The Turing Suite portrays Turing’s contribution at Bletchley Park. Paolozzi was interested in genius and wanted to depict Turing’s work in deciphering the Enigma Code. The vivid colours evoke the intensity of Turing’s inner vision of the natural world. Edinburgh’s Informatics Forum houses one of the limited edition printsuites.



## GREATER MANCHESTER AND EAST CHESHIRE:

A Science and Innovation Audit Report sponsored by the Department for  
Business, Energy & Industrial Strategy.

### Summary Report

MANCHESTER  
1824  
The University of Manchester

# Science and innovation audit of Greater Manchester and East Cheshire



**GMCA**  
GREATER MANCHESTER  
COMBINED AUTHORITY

 The  
Skills & Growth  
Company

 Greater Manchester  
Local Enterprise Partnership

 87/  
Quality and Innovation  
Enterprise Partnership

**new  
economy**

## Introduction and Context

At the core of the industrial strategy for both Greater Manchester (GM) and East Cheshire (EC) is the need to harness knowledge, innovation, skills and infrastructure to drive the local economy, create jobs and raise productivity. Realisation of the full potential from our science and innovation strengths will also benefit wider global societal challenges. These include climate change, energy security, transport efficiency, and a sustainable health and social care system. Informed by the results of our Smart Specialisation Platform analysis, emerging imperatives for growing the economy of the Northern Powerhouse and devolution of the health and social care budget to GM, we identified two ‘areas’ of focus for this Science and Innovation Audit (SIA):

1. ‘Core Strengths’ in **Health Innovation** and **Advanced Materials**, where we have existing, internationally-recognised excellence.
2. ‘Fast Growth Opportunities’ focused on the future potential of **Digital, Energy, and Industrial Biotechnology**, where our assets and capabilities offer real scope for future development.

Our guiding hypotheses were firstly that we have five areas of core strengths and fast growth opportunities which could be combined to release new synergies of innovation and productivity growth, and secondly that we would have to address gaps in our regional innovation ecosystem that are constraining our ability to do so in order to realise full potential. GM and EC’s collaboration on this Audit is borne out of shared ambition, functional geography, talent and assets, and a strong history of working together in partnership, such as joint action to secure a future for Alderley Park<sup>1</sup> (home to 150 bioscience companies), and the £31m Joint Cheshire and GM Life Science Fund<sup>2</sup>.

## Vision

Our vision derives directly from our first hypothesis that we can create a global competitive advantage by **driving synergies from our core capabilities**. Our areas of excellence create additional positive spill-overs and value when combined. This inter-connectedness will enable us to co-develop applications in new technologies. It will be achieved by linking our unique clusters of excellence in fundamental science

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<sup>1</sup><https://modern.gov.cheshireeast.gov.uk/documents/s31312/Alderley%20Park%20Development%20Prospectus%20-%20Appendix%201.pdf>

<sup>2</sup> <http://www.gmclifesciencesfund.com/>

with an ability to put that scientific knowledge into application – bringing together local and national partners. Three key opportunities identified are:

**i. Health – a globally leading centre for clinical trials**

We have the largest concentration of excellence in health research nationally outside South East England. Key facilities in support of cutting-edge research and innovation are set in the context of a large and stable population exhibiting significant health challenges. Health devolution to GM (£6bn p.a.)<sup>3</sup> has created the unprecedented opportunity for a concerted push towards innovation for both health and economic benefit. We have put in place a platform, Health Innovation Manchester<sup>4</sup>, to refocus our priorities around a system and place. Synergies with the digital sector (e.g. health informatics) allow us to drive towards becoming a globally leading centre for clinical trials.

**ii. Materials – rapid accelerator to application**

In advanced materials, the opportunities to develop ‘Graphene City’<sup>5</sup> highlight the unique presence of world-leading science (e.g. National Graphene Institute<sup>6</sup>) engaged with business and producing start-up companies. The next steps are to systematise the pathway through higher technology readiness levels (TRLs) with the opening of the Graphene Engineering Innovation Centre (GEIC)<sup>7</sup> and hence to turn our discoveries to applications. Particularly important is the accompanying training programme.

This gives us a large concentration of graphene scientists with additional entrepreneurship training. The Sir Henry Royce Institute<sup>8</sup> will create a national focus to overcome traditionally long lead-times and act as a “rapid accelerator” through TRLs to application, notably in the manufacturing sector.

**iii. GM as a full-scale test-bed and lead market to develop and demonstrate innovative technology**

Our fast-growth opportunities, digital and energy, as with health, combine excellence in research and facilities with a particular competence in mounting large-scale projects in the community. This is illustrated by the large-scale demonstrators,

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<sup>3</sup> <https://www.england.nhs.uk/2015/02/greater-manc-funding/>

<sup>4</sup> <https://www.healthinnovationmanchester.com>

<sup>5</sup> <http://www.graphene.manchester.ac.uk/explore/graphene-city/>

<sup>6</sup> <http://www.graphene.manchester.ac.uk/collaborate/national-graphene-institute/working-in-partnership/>

<sup>7</sup> <http://www.graphene.manchester.ac.uk/collaborate/geic/>

<sup>8</sup> <http://www.royce.ac.uk>

CityVerve<sup>9</sup> and Triangulum<sup>10</sup>, which enable whole systems to be tested and create multiple business opportunities. Industrial biotechnology is a capability of relevance for the concentration of related industries in the North of England. Focusing on synthesising new products and intermediates, it helps develop both sustainability and resilience in the move away from fossil fuels and feedstocks and offers the potential to address disease pandemics and tackle anti-microbial resistance.

### Strengths: Leading Edge Science and Innovation Capabilities

The foundation for progress in GM/EC rests in part upon a critical mass of acknowledged **Science and Innovation assets** in each of the selected areas in both the public and private sectors:

*Health Innovation:* e.g. Biomedical Research Centre (£28.5m, Sept 2016)<sup>11</sup>, Academic Health Science Centre, Manchester Cancer Research Centre, Alderley Park Science Park, Medicines Discovery Catapult hub<sup>12</sup>, Antimicrobial Resistance Research Centre, Citylabs, Precision Medicine Catapult spoke;

*Advanced Materials:* e.g. Sir Henry Royce Institute, National Graphene Institute, Graphene Engineering Innovation Centre, BP International Centre for Advanced Materials (BP-ICAM)<sup>13</sup>, Cockcroft Institute;

*Digital:* e.g. recognised as the UK's second digital hub through MediaCityUK, Farr Institute, CityVerve, Jodrell Bank, Hartree Centre (Sci-Tech Daresbury), and associated tech cluster<sup>14</sup>;

*Energy:* e.g. National Nuclear Laboratory, Dalton Nuclear Institute, National Grid High Voltage Laboratory, Birchwood nuclear cluster, Amec-Foster-Wheeler's High Temperature Facility; and

*Industrial Biotechnology:* e.g. Manchester Institute of Biotechnology, Waters Corporation's Mass Spectrometry Facility<sup>15</sup>, AstraZeneca's R&D facility, Antimicrobial Resistance Centre.

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<sup>9</sup> <http://www.cityverve.org.uk>

<sup>10</sup> <http://triangulum-project.eu>

<sup>11</sup> <https://www.gov.uk/government/news/new-816-million-investment-in-health-research>

<sup>12</sup> <https://md.catapult.org.uk/>

<sup>13</sup> <http://www.icam-online.org/>

<sup>14</sup> <http://www.techcityuk.com/wp-content/uploads/2016/02/Tech-Nation-2016>

<sup>15</sup> [http://www.waters.com/waters/en\\_GB/New-Mass-Spectrometry-Facility/nav.htm?cid=134653003&locale=en\\_GB](http://www.waters.com/waters/en_GB/New-Mass-Spectrometry-Facility/nav.htm?cid=134653003&locale=en_GB)

**Demonstrated scientific excellence** is also a key criterion. In health, the combined result of all health disciplines ranked University of Manchester (UoM) 5<sup>th</sup> in the UK for research power<sup>16</sup>, the highest-ranking institution outside the South East. UoM produced the second highest number of publications in the top 10% most cited in the field of advanced materials<sup>17</sup>. In our Fast Growth Opportunity areas UoM is consistently in the UK's top five both by volume of academic publication/ share of top 10% cited papers<sup>18</sup>.

**A dynamic, highly trained workforce** in the region includes a nationally significant concentration of training in clinical healthcare, one of the largest graduate pools in Europe, a strong concentration of STEM graduates/ postgraduates, and a long and successful history of entrepreneurship and industrial engagement<sup>19</sup>.

**City region governance** is conducive to innovation and growth. Our history of strong local governance is exemplified by the creation in GM of the first Combined Authority in the UK, and a shared strategy to create economic growth. Four devolution deals have been agreed for GM, including control over £6bn p.a. of health spending with commitment to use this to drive innovation through Health Innovation Manchester to serve a patient population with major healthcare challenges. GM and EC have a strong and effective record of effective partnership.

A well-established **public and private business support environment** includes examples of mature business support networks e.g. GM Business Growth Hub, and the Manufacturing Champions Network; access to private equity (including Venture Capital and Business Angels in GM and EC); a strong underpinning financial and professional service sector; four Enterprise Zones (one at Alderley Park); and incubator and accelerator space spanning the region and joining up GM and EC assets.

**Physical infrastructure** is available for a globally connected high tech sector. The region has excellent air, road and rail connectivity (Manchester Airport directly serves over 210 destinations)<sup>20</sup>, well-developed digital connectivity, and lower location costs for work/ living than London.

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<sup>16</sup> Research Excellence Framework (REF) 2014 based on volume x grade point average

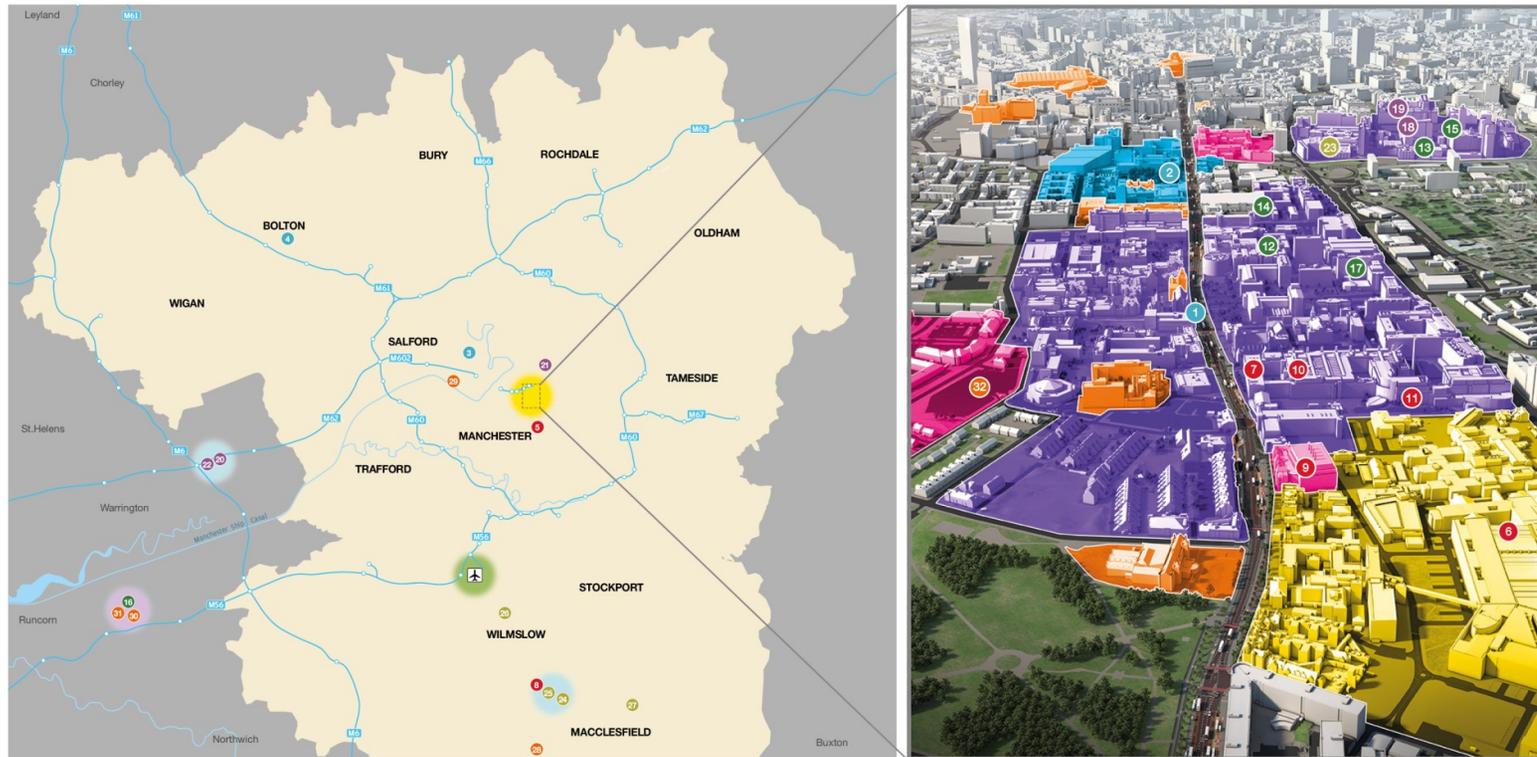
<sup>17</sup> *ibid*

<sup>18</sup> Scopus SciVal data for UoM ranked versus Russell Group comparators based on keyword field definitions

<sup>19</sup> "Mapping local comparative advantages in innovation", (BIS) 2015

<sup>20</sup> Manchester Airport Group "Route Development at Manchester Airport", 2016

Map: GMEC Audit Geography



Enterprise Zones	Universities	Health Innovation	Advanced Materials	Energy	Industrial Biotechnology	Digital
<b>Corridor Manchester</b>	1 University of Manchester (UoM)	5 Cancer Treatment / Research Cluster	12 National Graphene Institute	18 Dalton Nuclear Institute (UoM)	23 Manchester Institute of Biotechnology (UoM)	28 Jodrell Bank – HQ of Square Kilometre Array
<b>Alderley Park + Birchwood</b> (Part of Cheshire Science Corridor Enterprise Zone)	2 Manchester Metropolitan University	6 Central Manchester University Hospitals Foundation Trust	13 Graphene Engineering Innovation Centre	19 National Grid Power Systems Research Centre (UoM)	24 Antimicrobial Resistance R&D Centre	29 MediaCityUK
<b>Sci-Tech Daresbury</b>	3 University of Salford	7 UoM Faculty of Biology, Medicine and Health	14 Sir Henry Royce Institute for Materials Research and Innovation	20 Birchwood Nuclear Cluster	25 BioHub Incubator (Alderley Park)	30 Hartree Centre (STFC Daresbury)
<b>Airport City</b>	4 University of Bolton	8 Medicines Discovery Catapult	15 BP International Centre for Advanced Materials	21 NuGen HQ	26 Water's Corporation Mass Spectrometry HQ	31 Virtual Engineering Centre (STFC Daresbury)
		9 CityLabs (MSP)	16 The Cockcroft Institute (Sci-Tech Daresbury)	22 Amec Foster Wheeler's Nuclear Analytical Services Laboratory	27 AstraZeneca Pharmaceutical Development Facility	32 MSP - CityVerve (Internet of Things Demonstrator)
		10 Health eResearch Centre (The Farr Institute)	17 Moseley X-Ray Imaging Centre			
		11 Biomedical Research Centre				

## Gap Analysis

Our analysis shows that in each sector we have globally competitive multi-nationals accompanied by clusters of innovative SMEs. In terms of skills and talent, a higher proportion of our area's workforce is employed in science, research, engineering and technology professions than the England average<sup>21</sup> but a significant share of the local population continues to have no qualifications at all. Around knowledge transfer and leadership, there are more firms in EC engaged in product or process innovation than the English average, and their level of business R&D expenditure per person one of the highest nationally<sup>22</sup>. Yet, across the whole of our geography, nearly half of firms are still not 'innovation-active'. Productivity levels remain below their potential, with GVA per capita in GM and average annual full-time pay significantly behind the England average<sup>23</sup>. In finance, although we have access to one of the largest private equity pools in the UK, access to venture capital remains behind the South East. Such access is needed to help bridge the equity gap from start-up to scale-up.

There is an outstanding offer of place assets, now linked more clearly as a system following this audit. Technology space and support services and institutions are situated in a continuum from MediaCity in Salford, through Corridor Manchester and Airport City to Alderley Park and the Cheshire Science Corridor. These form a globally competitive innovation district. There are strong examples of collaboration and networking across GM/EC, but we need to do more so that we can realise the full potential of our assets to drive innovation and commercialise our research locally. We must also support smaller firms to acquire and build the absorptive capacity to take advantage of the opportunities created by our science assets.

The audit shows that our innovation support system lacks some key elements in knowledge production (missing complementary assets), development of talent (addressing key skills and management deficits) and business support (improving the environment for innovative, growing firms). We need to

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<sup>21</sup> "Mapping local comparative advantages in innovation", (BIS) 2015

<sup>22</sup> Ibid

<sup>23</sup> Ibid

increase productivity, raise skills and qualification levels across the workforce, and extend the benefits of our recent strong growth to the less favoured parts of our region.

### Key Ambitions

Following from our analysis of strengths and gaps we will follow two main lines of action:

#### **1. Strategic investment to capitalise on the key intersections and opportunities**

We must extract maximum value from existing assets and those under construction, but need to continue to invest (from our own and external funds) to maintain world-class excellence and remain at the forefront of international developments in our areas of smart specialisation. Notably this will exploit the synergies between our areas of strength in order to develop route-ways to the market.

#### **Pankhurst Centre to bring together physical science capabilities for health benefit**

We can reinforce inter-connectedness by making some important strategic investments. Central to our plans is the Pankhurst Centre for Research in Health, Technology and Innovation. This would be a path-breaking, cross-disciplinary Institute bringing together clinical research with materials science, informatics, engineering and computer science to address major health problems, and unlock synergies between our strengths of health and materials plus digital and biotechnology. Its ‘bi-directional’ nature means new discoveries will seek health applications and respond to health needs to find solutions. It will be both place-based and virtual, with a core of at least 100 research leaders from diverse disciplines working together, but drawing upon a wider group of researchers beyond.

#### **Maintain the strength of our science assets with key critical investments**

In the short-term, we have identified a small number of projects which address gaps and opportunities in our regional ecosystem and are strong candidates for investment to help do this.

#### **2. Strengthening our innovation support ecosystem**

##### **Enhancing collaboration**

We will drive alignment of our science assets with our local business base to maximise economic impact, stimulating a broader cultural change around interdisciplinary pathways to the market.

### **Nurturing talent**

We must ensure the right local skills mix is in place to drive innovation, reinforce our identified scientific strengths and improve our ability to attract and retain talented individuals. GMEC needs to invest further in the development of the skills required to drive its key innovation sectors and assets, particularly higher-level technical skills. We plan to establish an **Institute of Technology**, which would work closely with GMEC's universities, enable progression from FE, be driven by business demands and leadership and foster innovation in SMEs.

Leadership and management capacity for our innovative sectors are also critical. We need investment in our Business Schools to ensure they can play a pivotal role through their research and training in guiding development of health devolution and of our advanced innovative sectors. We need to raise awareness of a diverse workforce to drive innovation.

### **Improving business support**

As we build critical mass, there will be increased opportunity to ensure businesses gain access to diverse finance support to help them to scale-up. We need to realise the benefits of 'absorptive capacity' within SMEs, improving their ability to integrate new information for commercial ends. This includes increasing the provision of adequate space for both start-ups/ scale-ups and leveraging in smarter procurement practice from the public sector to incentivise innovative practice (e.g. through data-sharing initiatives such as GMConnect and Datawell).

### **Networking and Collaboration**

Our integrated governance, deep culture of collaboration between government, business, academia, and health, and strong partnership between GM and EC gives a powerful platform to implement the opportunities shown in the Audit. We will work with partners nationally (including across the North) and internationally as we pursue global export and inward investment opportunities.

The region is characterised by an exceptional level of **partnership and connectivity**. There are close strategic and operational collaborations between our universities, the business community, local government and public sector partners, health and social care providers, and charities. Connectivity is demonstrated by a series of strategic alliances, e.g. in healthcare and medicine (see strengths above); and national and international networks (e.g. EU €1bn Graphene Flagship<sup>24</sup>, £20m Connected Health Cities<sup>25</sup>, UK's only Internet of Things demonstrator (CityVerve), and other assets noted above). We already have strong international **partnerships** in each of the areas of strength identified and rapidly growing interest from global companies to have a footprint in GM (particularly at Citylabs) and EC (notably Alderley Park). Major multi-national companies include NCC Group, NNL, NuGen, Hitachi, BP, Amec-Foster-Wheeler, Waters, Cisco and AstraZeneca.

The audit process has driven added-value in verifying our own internal assessments of strengths, weaknesses and opportunities; strengthening our collaborations across the region; building on our partnerships; and identifying future priorities, particularly for innovation and business development. During the process, we held 10 meetings with over 40 partners - including 20 companies and two workshops (health innovation, and advanced materials). This led to the reinforcement of our strategy with other partners, introduction of industry partners to each other and important feedback, development of new collaborations and identification of areas that need to be strengthened. For example, UoM, MMU and the University of Salford are now working together on health education and innovation; while LEPS across the North are collaborating more closely on joint actions to understand and drive innovation.

The Audit has demonstrated a historic opportunity to develop our innovation ecosystem as an accelerated pathway to the market for regional and national

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<sup>24</sup> <http://graphene-flagship.eu/project/Pages/About-Graphene-Flagship.aspx>

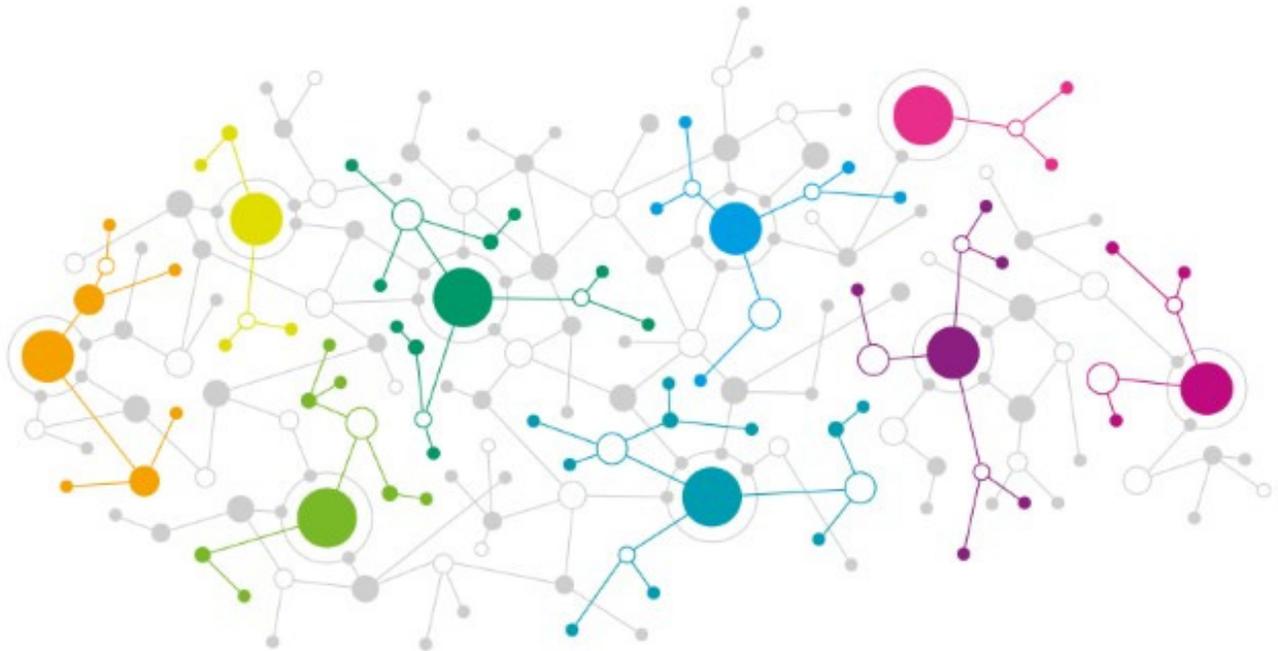
<sup>25</sup> <http://www.manchester.ac.uk/discover/news/chancellors-20m-to-use-cities-data-to-improve-healthcare/>

social and economic benefit. It provides us with a platform for shared action going forward.

A Science and Innovation Audit Report for  
**THE MIDLANDS ENGINE,**  
sponsored by the Department for  
Business, Energy & Industrial Strategy

Summary Report

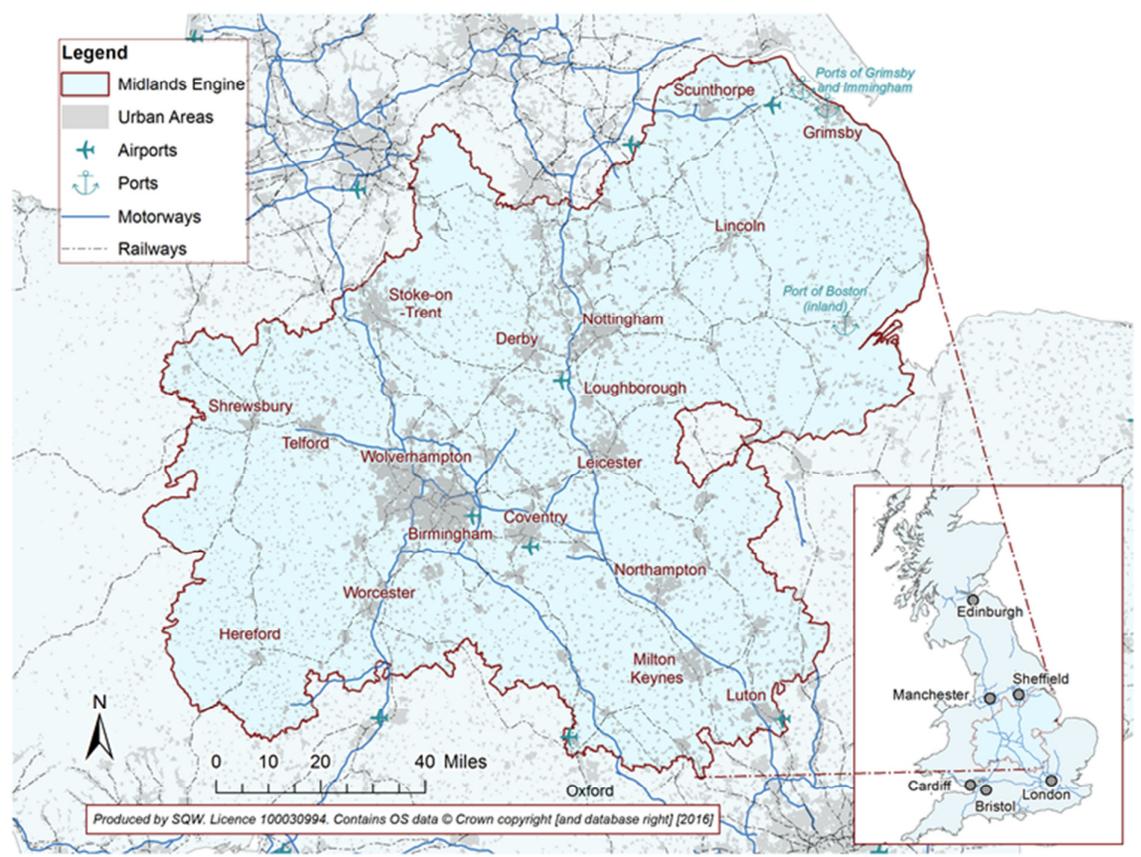
October 2016



## Introducing the Midlands Engine

The Midlands Engine provides the heartbeat to the UK economy. A diverse and substantial area, the region covers 11 Local Enterprise Partnership (LEP) areas and includes internationally significant core cities such as Birmingham and Nottingham, growing regional hubs like Coventry, Derby, Leicester, Lincoln, Milton Keynes, Stoke-on-Trent, and Wolverhampton, and a high quality natural environment, including the Peak District National Park. The Midlands Engine region also includes market and county towns like Northampton, Shrewsbury and Stafford, serving as economic, leisure and service centres.

Figure 1: The Midlands Engine



The Midlands Engine is a £230 billion economy, generating 15% of the UK’s Gross Value Added (GVA), with five million employees, and approaching half a million businesses.i It is built on a globally significant advanced manufacturing base, with demonstrable strengths across multiple sectors and technology areas, drawing on world leading science and innovation capabilities. Our tier one businesses and their wider supply chains are highly integrated in international markets. Last year, Midlands Engine firms accounted for 17% of all UK exporters; notably, our businesses generated approaching a third (31%) of UK exports in ‘Machinery and Transport’ goods.ii

However, despite these clear sectoral strengths, like many other areas across the UK, we underperform on productivity. The latest data (2014) indicate GVA per filled job in the Midlands Engine at £44.6k, against £49.85k nationally.iii This Science and Innovation

Audit (SIA) has sought to identify concrete market opportunities and underpinning competencies that offer real potential for the Midlands Engine to tackle its persistent productivity challenge and drive long-term growth. Additionally, the SIA demonstrates how the Midlands Engine can contribute fully to an exciting and vibrant UK-wide industrial strategy.

### Understanding the SIA journey, added value and legacy

Underpinned by a robust evidence base, the Midlands Engine SIA has been an inclusive, transparent and substantial research process. The SIA has been led by a high-level Delivery Group – including representatives from businesses, LEPs, universities, translational research bodies, network organisations and science parks across the region – working on behalf of the Midlands Engine. Critically, the SIA unambiguously is focused on enabling and driving productivity growth.

Through a series of six workshops attended by over 150 stakeholders, and an online consultation exercise that secured responses from over 100 stakeholders from 65 separate organisations, we have engaged extensively with our science and innovation partners across the Midlands Engine geography. This engagement covered the full spectrum of science and innovation activity. Importantly, the private sector has been heavily involved in and throughout the process, including both individual SMEs and representative groups, and multi-national firms embedded fully in the region's innovation ecosystem.

Coming together as a fully integrated science and innovation community for the first time through the SIA – in a region stretching from Grimsby on the North Sea to Hereford on the Welsh border, and from the High Peak bordering Greater Manchester, to Luton and Bedford adjoining Greater London – we have used the SIA process to build momentum with, and trust between, partners and stakeholders. By fostering new relationships and identifying synergies, the SIA process itself has helped to identify, develop and embed both the concept and content of the Midlands Engine innovation ecosystem.

Crucially, the process has started to break down the barriers that previously constrained collaborative innovation and commercialisation activity across arbitrary administrative boundaries, notably thinking and acting from the perspective of the 'the east or the west'. The process has also encouraged and developed linkages and relationships within and between industry sectors, technology areas, scientific research communities, and local decision makers, that were to an extent lacking just a matter of months ago prior to the SIA. We are now engaging together in creating new opportunities that will benefit our whole region within the broader UK ecosystem, through initiatives such as Marketing Birmingham and Birmingham Science City's Midlands Engine Conference on Medical Devices, the coming together of the Space LEPs to maximise our contribution to the UK's industrial strategy and our ambitions to create a truly integrated transport innovation hub across our region. It is vitally important that we sustain these linkages and relationships as we move forward together to action opportunities identified in this SIA.

Alongside our inclusive approach to partner engagement, we have been very focused in our analysis. The scale of the Midlands Engine provides significant opportunities – that we have started to see bear fruit already – by enabling collaboration across a diverse range of fields, and providing a critical mass of science and innovation competence with which

industry can collaborate. However, this scale also provides a challenging backdrop for an SIA; put simply, the breadth of the science and innovation offer is very significant in a place with more people than London, New York or Singapore and almost four times the population of Silicon Valley.

The challenge is particularly pronounced in seeking to identify the specific target areas of opportunity and excellence within this complex and crowded landscape. Ultimately, this involves making tough choices on what to focus our effort and resources on – the evidence underpinning and informing these difficult strategic choices are the focus of the main SIA report.

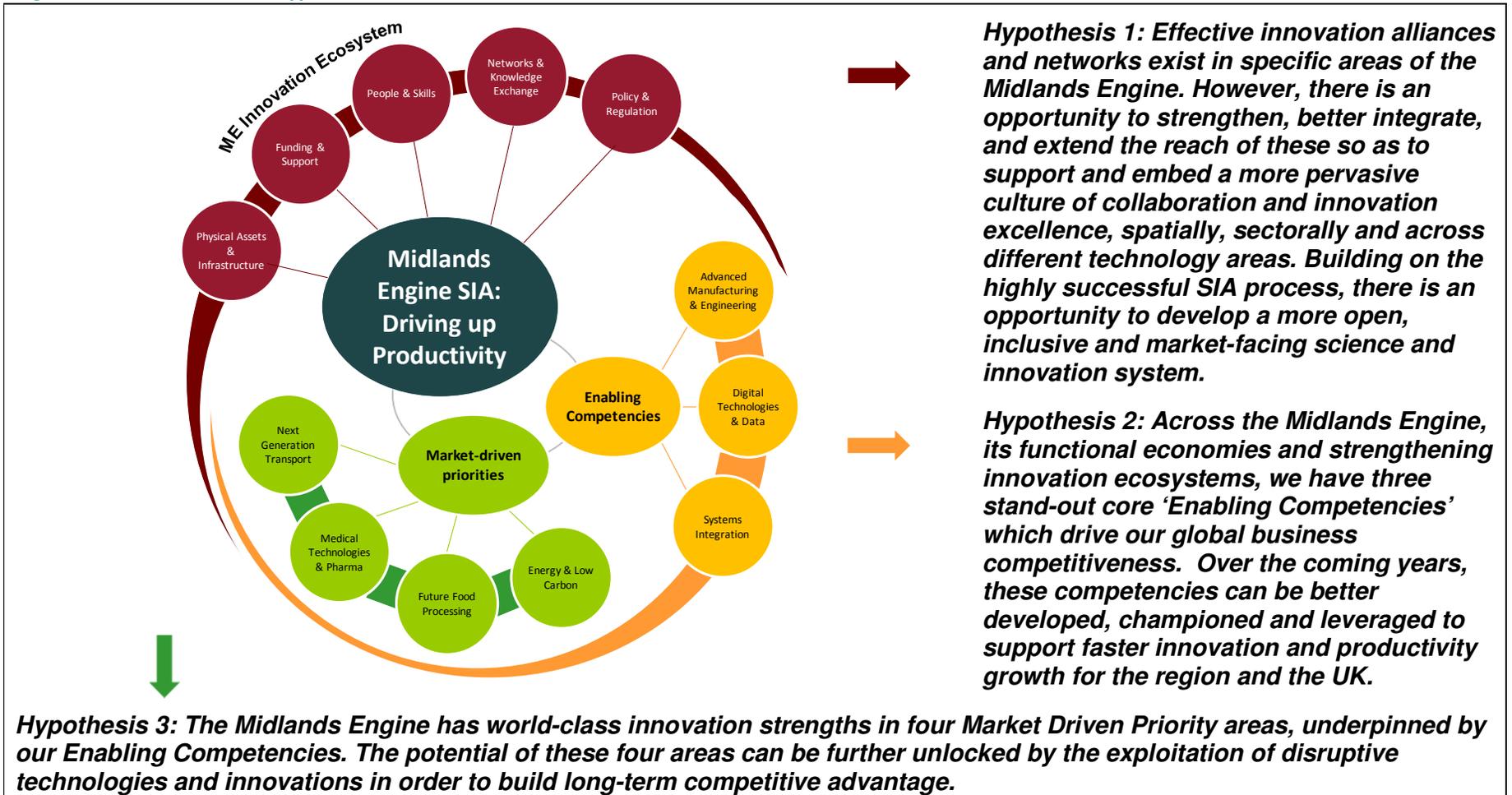
Despite these challenges, encouragingly, the SIA opportunity has been seized fully by regional partners. However, there is recognition that the SIA forms the first step in a longer journey to develop a competitive and integrated innovation ecosystem for the Midlands Engine, and its constituent areas. More detailed and comprehensive action planning work will continue over the next few months and beyond, building on the platform provided by the SIA. We have also sought to ensure that the SIA process and resulting outputs can be used to define investment priorities by our component LEPs and Combined Authorities. The Midlands Engine Innovation Group will be a very considerable force in achieving delivery success.

### SIA hypotheses, Framework and Vision for growth

Six themes were identified in our SIA Expression of Interest: transport technologies; agri-food and drink manufacturing and production; advanced manufacturing and engineering; healthcare, life sciences and translational medicine; energy and low carbon technologies; and creative, digital and design. The themes were deliberately broad, reflecting the scale and diversity of the region, and to ensure that the SIA process did not ‘miss’ significant innovation assets or activity from the outset. The SIA was tasked with testing the themes, and drilling down to focus on particular specialisms where the region had genuine excellence (at national and or international levels), leadership, credibility and opportunity. Importantly, the SIA is unambiguously focused on driving productivity growth.

We adopted a process that identified **four market driven priorities** where there are clear economic growth opportunities and very strong alignment with the Midlands Engine’s strengths and distinctive capabilities. Additionally, **three enabling competencies** that underpin and complement these market priorities, and drive our business competitiveness, emerged. The competencies are crucial for successful knowledge-based economies, and these are specific areas where the Midlands Engine, according to the SIA assembled evidence, has a critical mass of assets and expertise. These exist within a much broader **innovation ecosystem** of hard and soft infrastructures and structural factors. Together, these elements formed the basis for the hypotheses to be tested through our SIA Growth Framework (Figure 2). Our Framework is focused, but it is also sufficiently flexible so as to respond to emerging opportunities and contextual shifts.

Figure 2: SIA Framework and Hypotheses



Source: Midlands Engine SIA

The definition and scope of the enabling competencies and market driven priorities are set out below.

### Enabling Competencies

**Advanced Manufacturing and Engineering:** covering the region's pervasive leading-edge technical knowledge, and practical know-how, in designing, validating, producing, and servicing new products and industrial processes, across a diverse and increasingly integrated range of sectors and markets.

**Digital Technologies and Data:** covering the strengths in the region's academic, research and industrial base in exploiting and understanding data and information, including satellite-enabled data, and the use of digital technologies in product, process and service development and research commercialisation.

**Systems Integration:** covering the strengths in the region's academic, research and industrial base on how increasingly complex systems – from energy and transport systems, through to manufacturing and service delivery – can be better designed, managed and operated.

### Market Driven Priorities

**Next Generation Transport:** covering aerospace/space, automotive, motorsport and rail sectors, with a focus on high performance system simulation/modelling; advanced digital design/physical validation; advanced materials/processes; and digital manufacturing, supply chain and service management

**Medical Technologies and Pharmaceuticals:** covering medical devices, diagnostics (including in vitro diagnostics and diagnostic imaging), software as a medical device, and pharmaceuticals

**Future Food Processing:** covering the areas of 'food processing efficiency', 'delivering a zero waste food chain'; and 'food product innovation' in the food and drink sector

**Energy and Low Carbon:** covering geo-energy, thermal energy systems, nuclear, energy storage and smart integrated energy systems.

*Source: Midlands Engine SIA*

The framework is consistent with and sets the context for the vision articulated by the recently established Midlands Engine Innovation Group to:

*Convert the great research from our universities and wider research community into commercially successful products and processes for the economic benefit of the country, and address market failures and market needs, creating a self-sustaining, long-term approach to realising the power of innovation in generating economic and productivity growth for the region. We will create a system that bridges the 'readiness' gap that traditionally exists between concept-proven research and commercial financial investment. We will generate the conditions necessary to build confidence for that investment, accelerating the adoption of technology by industry, and thereby begin a cycle of continual growth for the Midlands Engine region.*

### Highlights of our science and innovation excellence

The Midlands Engine is home to a nationally and internationally competitive portfolio of academic, translation research, and industrial R&D assets and strengths. Our asset base includes 27 universities, over 50 research technology organisations, science parks and innovation centres, and R&D centres of major multi-national firms and a host of innovative SMEs.

Reflecting both the breadth and quality of our research base, across each and every one of the 36 Units of Assessment of the 2014 REF, at least one Midlands Engine university was in the top 20 nationally in research Power or Quality; put another way, the Midlands Engine is home to some of the UK's leading science and research across all disciplines.

Table 1 overleaf provides a headline depiction of some of our key assets and strengths, across the Technology Readiness Level (TRL) spectrum; considerable further detail is provided in the main SIA report.

**Table 1: High level summary of key assets and strengths across the TRL spectrum**

<b>Experimental research</b>	<b>→</b>	<b>Applied R&amp;D</b>	<b>→</b>	<b>Technology implementation</b>
<p>27 universities, with approaching half a million registered students</p> <p>Institutions securing 30% of UK Research Council funding over 2010-15, with higher shares in areas including Energy, Manufacturing, Systems Engineering, Instrumentation, Sensors and Detectors, and Design</p> <p>Universities outperforming the national average on citations analysis in subject areas including Chemical Engineering, Chemistry, Energy, Physics and Astronomy, Medicine, and Pharmacology, Toxicology and Pharmaceuticals</p> <p>Home to the £180m Energy Research Accelerator, a collaboration of Midlands universities designed to tackle some of the biggest energy challenges facing the UK</p>	<b>→</b>	<p>Energy Systems Catapult, Transport Systems Catapult, and High Value Manufacturing (HVM) Catapult based in the region</p> <p>Significant RTOs including: East Midlands Satellite Applications Centre of Excellence; Manufacturing Technology Centre and Warwick Manufacturing Group HVM Catapult centres; Advanced Propulsion Centre; Aerospace Technology Institute; HORIBA MIRA; Rail Innovation and Development Centre; National Centre for Food Manufacturing; Institute for Translational Medicine</p> <p>25 science parks and innovation centres, across all growth sectors and industries</p>	<b>→</b>	<p>Midlands Engine businesses accounted for 17% of business investment in R&amp;D, and 18% of employees in R&amp;D in 2014/2015</p> <p>Midlands Engine responsible for 18% of patents submitted in the UK over 2004-13; increasing to over a quarter of UK patents in Food Chemistry; Engines, pumps, turbines; Materials, metallurgy; and Transport</p> <p>Major multinational R&amp;D intensive firms embedded in the regional economy including Rolls-Royce (Next Gen Transport and Energy), Jaguar Land Rover (Next Gen Transport), Mondelēz International, PepsiCo and Unilever (Future Food), 3M, Boots (Med-tech and Pharma); National Grid and Alstom (Energy).</p>

*Source: Midlands Engine*

The region contains concentrations of activity in our identified market priorities including<sup>iv</sup>: around 85,000 people employed in core transport technology sectors, of automotive, rail and aerospace/space, each with a Location Quotient (LQ) above one, and a further 75,000 employees in supporting technical and research disciplines. There are key clusters of businesses and innovation activity around Derby (rail and aerospace), Leicester (space) and Coventry/Warwickshire (automotive); the region is also at the centre of the High Performance Technology Cluster, one of the UK's leading concentrations of knowledge-based and internationally competitive technical and manufacturing-led businesses, centred around Silverstone, Northampton and Milton Keynes around 118,000 employees in food and drink manufacturing, with an overall LQ of over 1.5 demonstrating the high level of specialisation in food and drink manufacturing across the Midlands Engine, with significant employment across the region over 1,000 firms in the medical technologies and pharmaceuticals core and support sectors across the region, with particular concentrations in Nottingham and Birmingham, reflecting the presence of incubator facilities/services at BioCity Nottingham and the Birmingham Biohub, and across the east of the region, reflecting the area's legacy of pharmaceutical production, including opportunities around the Charnwood site in Loughborough around 180,000 employees in energy and low carbon technologies across the region, with particular concentrations of activity in Birmingham and Nottingham, and significant employment in energy and support disciplines evident across the region and its local areas.

### Growth opportunities

There are clear growth opportunities within our four market driven priorities, underpinned by our three enabling competencies, created by the Midlands Engine's strengths and distinctive capabilities:

- **Next Generation Transport:** there are immediate opportunities around technology development (simulation and modelling; advanced digital design and validation; advanced materials and manufacturing; digital manufacturing, supply chain and service management) for aerospace/space, automotive, high value motorsport and rail, including significant complementarities and cross-overs with the Energy and Low Carbon opportunity
- **Medical Technologies and Pharmaceuticals:** distinctive opportunities exist around diagnostics and imaging, sustaining our activities in pharmaceuticals, using the region's stable ethnic diversity as a living laboratory for improving health outcomes, growing our success in trauma and rehabilitation, and combining health and environmental data to support innovation as next generation transport and low carbon economy opportunities are progressed
- **Future Food Processing;** the Midlands Engine region is the source of a significant proportion of the UK's primary food production. Opportunities for major productivity growth are particularly attractive in efficient food processing, zero-waste food chains, and food product innovation.
- **Energy and Low Carbon;** the recently launched Energy Research Accelerator and location of the Energy Systems Catapult represent major investments in energy in the Midlands Engine. We need to build on this and capitalise on our opportunities in geo energy, thermal energy systems, nuclear, energy storage and smart integrated energy systems.

## Moving Forwards

This SIA has created the opportunity for the key players around the Midlands Engine area to come together and identify clear and current opportunities for growth. Unsurprisingly, in a region of the reach and vibrancy of the Midlands, significant efforts are already underway that provide a close match to some elements of the market opportunities we have identified. In particular:

- Midlands Innovation's thinking on 'Transport Innovation for a Low Carbon Economy' that takes forward aspects of the Next Generation Transport theme
- The proposed National Space Park, which would bring a step change to space research and space-enabled data service provision
- Proposals for Life Science Opportunity Zone status at Charnwood
- Emerging proposals for building on the significant investments made in the region through the Energy Research Accelerator (ERA).

These projects are welcome early steps in taking forward key elements of this ambitious audit and broader growth agenda. However, in order to unleash our full productivity potential and deliver the economic transformation that this SIA has shown is possible, more will need to be done. The SIA has created a new and effective focus, drawing together the main economic actors across the Midlands. It has crystallised a shared set of opportunities, channelled energy and ambition, and illustrated where our true strengths and potential lies. The baton has now been passed to the Midlands Engine Innovation Group to take these analyses and the head of steam created around them, and configure them into major strategic priorities framed in the Government's developing industrial strategy. This is a task that the Midlands Engine will take forward over the coming months so that a truly transformative proposition can be brought to deliver on our full productivity potential.

<sup>1</sup> Subregional Productivity: Labour Productivity (GVA per hour worked and GVA per filled job) indices by UK NUTS2 and NUTS3 subregions (data for 2014); Business Register and Employment Survey (data for 2014); and UK Business Counts – Local Units (data for 2015)

<sup>1</sup> UK Regional Trade in Goods Statistics (data for 2015)

<sup>1</sup> Subregional Productivity: Labour Productivity data as above (data for 2014)

<sup>1</sup> Sources: Business Register and Employment Survey (data for 2014); and Office of Life Sciences Strength and Opportunity dataset (data for 2015)

A stylized map of the Sheffield City Region and Lancashire, showing various cities and towns. The map is divided into two main areas: Lancashire on the left and the Sheffield City Region on the right. The cities are labeled in white text on a dark teal background.

## SHEFFIELD CITY REGION & LANCASHIRE

Lancaster

Blackpool

Blackburn

Preston

Burnley

Barnsley

Doncaster

Rotherham

Sheffield

Chesterfield

# Driving productivity growth through innovation in high value manufacturing

## Summary report

*A Science and Innovation Audit report sponsored by  
the Department for Business, Energy & Industrial Strategy*

October 2016

“The SIA priority focus areas are essential to enable UK industry to keep pace with its competition and position the north of England as a continued global sector leader in advanced engineering and manufacturing.”

**David Holmes**

*MAI Manufacturing Operations Director,  
Military Air & Information, BAE Systems  
plc*

## Foreword

“The Science and Innovation Audit is a vital mechanism to ensure that much needed investment is targeted at the priority projects and programmes that will stimulate productivity and economic growth in Lancashire, Sheffield and across the Northern Powerhouse region.”

“There is a critical need to build on the productivity performance of the advanced engineering & manufacturing sector, particularly within SMEs, to ensure we remain globally competitive. Key to delivering this will be maximising existing and developing new collaborations between industry and our science and innovation assets. This successful formula can be seen in practice with the emerging Northern Advanced Manufacturing Innovation Corridor and how this SIA drives new and better partnerships to deliver what’s required.”

“The pace of change within advanced manufacturing technologies is constantly accelerating and the UK’s global competitors are well placed to take advantage of the potential benefits that step changes such as Industry 4.0 present. The SIA priority focus areas are essential to enable UK industry to keep pace with its competition and position the north of England as a continued global sector leader in advanced engineering and manufacturing.”



*David Holmes*  
MAI Manufacturing Operations Director,  
Military Air & Information, BAE Systems  
plc

“Between the geographies of the Sheffield City Region and Lancashire lies a unique opportunity. One which the UK economy desperately needs. Here lie the components required to equip the UK to deliver the vision of the 4th industrial revolution, Industry 4.0. Within our existing Northern Advanced Manufacturing Innovation Corridor, we have strong high value manufacturing industrial bases, innovative excellence, world-class science and multi-level skills training; ensuring that the region is ready to bring the right skills, people and technology to close the productivity gap not just for the North but for the UK as a whole”.

“Both our individual regions are also ambitious about building on existing assets through the development of their own Innovation Districts coupled with a drive and willingness to collaborate; as demonstrated by the joint commitment to develop a NW AMRC (Advanced Manufacturing Research Centre) with private sector partners in the aerospace, automotive and energy supply chain sectors”.

“The SIA also talks about productivity, competitiveness and winning work. To achieve this we need not only industrial investment and participation in skills, innovation assets and SME supply chains but we also need strategic ownership, vision and funding from Government to lead the charge”.

“This SIA provides a robust picture of innovation, industrial excellence and world-class research and I am confident that the other SIAs conducted across the UK will also show the same. What we need now is a cutting-edge national strategy to help regions like ours to deliver real change which will create economic growth and with it the jobs and opportunities which are so crucial for all in our communities”.



*Professor Sir Keith Burnett, CBE, FRS, FRSW*  
Vice-Chancellor of the University of Sheffield

## Introduction & context

**In Autumn 2015 the UK Government announced regional Science and Innovation Audits (SIAs) to catalyse a new approach to regional economic development. SIAs enable local consortia to focus on analysing regional strengths and identify mechanisms to realise their potential. In the Sheffield City Region (SCR) and Lancashire a consortium was formed to focus on our strength in high value manufacturing. This report presents the results which include broad-ranging analysis of the audit region’s capabilities, the challenges and the substantial opportunities for future economic growth.**

The context for this audit is set by a UK-wide economic problem: stagnation of productivity growth since 2008. The audit region of Sheffield City Region (SCR) and Lancashire contributes to this; regional productivity is well below the average for England.

This regional productivity gap has been attributed to three factors<sup>1</sup>: structural change in the economy through a shift away from manufacturing to lower productivity activities; a skills problem; and not enough innovation and entrepreneurship. This audit proposes concrete and substantive measures in response to each of these issues.

The two Local Enterprise Partnership (LEP) areas comprising the Audit region share a specialism in high value manufacturing (HVM) in key sectors of *aerospace*, *energy* (particularly *nuclear*), transport (particularly *rail*), and *health technology*. Manufacturing capability in these sectors makes a key contribution to the economy of the wider North. The audit finds that there is a highly complementary range of globally significant research excellence between the two regions, as well as successful and established innovation assets that underpin this industrial capability.

But manufacturing is changing. The full integration of digital capabilities in manufacturing – often referred to as ‘*Industry 4.0*’ - and adoption of new materials and manufacturing processes, will drive high productivity growth in businesses able to adopt them. The hypothesis tested by this audit is that **the region has the necessary underpinning research and innovation assets in relevant areas of engineering, digital and data science to underpin a transformation in the performance of the region’s manufacturing base.**

Translational research facilities are crucially important for the spread of new technologies, especially to the Small and Medium Sized Enterprises (SMEs) that are such an important part of the regional economy. The capacity for excellent management and leadership will be no less important, together with a system for developing technical skills at all levels, especially those digital skills that will drive Industry 4.0.

There is a growing consensus on the need to work collaboratively across the audit region, as a partnership between private and public sectors, to capitalise on the assets already in place within and between the two LEP areas by realising the potential of the region’s high value manufacturing to drive economic growth and to close the productivity gap with the most prosperous parts of the UK. Significant initiatives have already begun with this goal in mind.

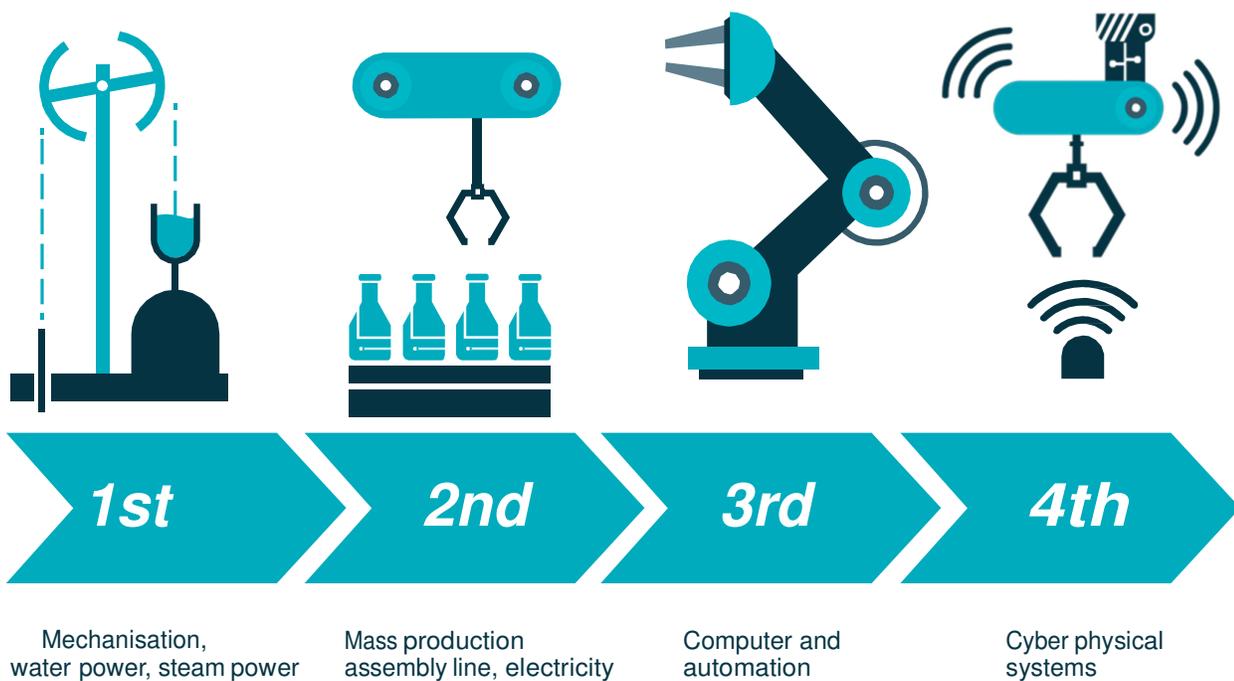
The vision presented here is of a “Northern Advanced Manufacturing Innovation Corridor”, bringing existing, emerging and new science and innovation assets and programmes into collaboration with industry to drive productivity growth in advanced manufacturing and key linked sectors across the region to world-class levels.

The opportunity is to invest in key schemes which will enable the region to deliver innovation so the UK can maximise the benefits of Industry 4.0.

<sup>1</sup>Transport for the North, Independent Economic Review of the Northern Powerhouse, 2016. The five work-stream reports are available from the SQW website here: [www.sqw.co.uk/insights-and-publications/northern-powerhouse-independent-economic-review/](http://www.sqw.co.uk/insights-and-publications/northern-powerhouse-independent-economic-review/)

“ Between the geographies of the Sheffield City Region and Lancashire lies a unique opportunity. One which the UK economy desperately needs. Here lie the components required to equip the UK to deliver the vision of the 4th industrial revolution, Industry 4.0. ”

Professor Sir Keith Burnett, CBE, FRS, FRSW  
Vice-Chancellor of the University of Sheffield



**The vision presented here is of a “Northern Advanced Manufacturing Innovation Corridor”, bringing existing, emerging and new science and innovation assets and programmes into collaboration with industry to drive productivity growth in advanced manufacturing and key linked sectors across the region to world-class levels.**

## The vision

The region has the elements required to be a globally significant centre for innovation and translational research, ensuring the rapid take-up in manufacturing industry of new materials and processes, new business models and the ubiquitous digital technologies of Industry 4.0. The resulting resurgence in high value manufacturing will drive productivity growth and strengthen the economy of the region, the wider North, and the UK more generally.

The suggested investments will build on an already strong base of existing and emergent science and innovation infrastructure and programmes, as follows:

- build on existing outstanding translational research assets (£207m research grant income per year<sup>2</sup>)
- join up the skills landscape across the region from apprenticeships to Higher Education (HE) (sector-leading schemes already in place, in partnership with the key industrial sectors)
- develop excellent leadership and management, and support new enterprise and entrepreneurship (the HE sector leader in business and management is within the audit region, and has particular strengths in advanced manufacturing and SME engagement)
- support the internationalisation of the business base (innovation assets in the region have strong global links and are already being replicated in Korea, the US and China)
- expand the research base in areas that will be important for Industry 4.0 and the future of manufacturing (e.g. robotics, data analytics, new materials and processes for lightweighting, resource efficiency, leadership and management)

Strategic delivery of the vision will build on initiatives already taking place within and between the two LEP areas, based on the **Advanced Manufacturing Innovation District (AMID) concept** which recognises the need for a ‘whole-place’ approach to the development of innovation ecosystems. Successful delivery of an Innovation District requires a high level of interconnected physical, economic and networking assets. The audit has considered the existence of these and has concluded that there is significant strength in each of the three areas, but a need to further develop and raise the performance of networking assets within and between the two regions.

Advanced Manufacturing Innovation Districts are being developed at each end of the proposed corridor (Sheffield/Rotherham boundary and Salmesbury, near Preston), and there is a need to connect the two. The North West AMRC at Salmesbury, which links to the University of Central Lancashire’s (UCLan) Engineering Innovation Centre, is the first substantial project which will begin to achieve this, and will formalise the link between the two Innovation Districts as it represents a formal partnership between Lancaster and Sheffield Universities

Success in implementing this vision will be demonstrated by:

- more rapid adoption of new technology by the existing industry base, particularly SMEs
- greater proportion of businesses led and managed at the highest level
- increased rate of formation of innovative new companies, and enhanced growth of existing businesses
- inward investment by multinational manufacturing companies at the technological frontier
- broad skills base, talented people attracted to and retained in the region
- growing high value services sector in support of manufacturing
- enhanced regional export performance and international collaborations
- significant and measurable improvement in productivity outcomes across our advanced manufacturing sectors and throughout the regional economy

<sup>2</sup>HESA research income for 2014-15, from HEIDI.

## Key strengths

### HE research base

- Six universities: £207m of grant research income (2014), 90% of research internationally recognised or better.<sup>3</sup>
- Tripling of engineering research income in the decade to 2014-15.<sup>3</sup>
- REF results and research grant funding rank the University of Sheffield as a leader in the UK for engineering, and citation results illustrate the impact of its outputs globally.<sup>3</sup>
- Research impact outperforming national averages in key underpinning areas for Industry 4.0, including Human-Computer Interaction, Computer Graphics/ Computer- Aided Design, Artificial Intelligence, Ceramics and Composites, Transportation, Business and International Management.<sup>4</sup>

### Translational research centres <sup>5</sup>

Translational research centres bring academia together with global and regional businesses, to accelerate the adoption of new technology.

Examples in the region include:

- The University of Sheffield's Advanced Manufacturing Research Centre Group. £280m capex, £38m pa turnover. Includes: Factory 2050 (research/demonstration factory for Industry 4.0), AMRC with Boeing (part of the HVM Catapult), Nuclear AMRC (part of the HVM Catapult).
- EPSRC National Centre for III-V Technologies at The University of Sheffield
- UCLan Engineering Innovation Centre (EIC), £40m capex 7000 sq m.
- Sheffield Hallam University National High Power Impulse Magnetron Sputtering Technology Centre (HIPIMS).
- Lancaster University Health Innovation Campus (£167m capex, planned).

### Public sector R&D facilities

- The National Nuclear Laboratory (based at Sellafield) has a laboratory in leased facilities at Westinghouse's Springfield plant, near Preston.
- Large teaching hospitals, with many leading clinicians and academics active in collaborative research with nearby universities and the private sector.
- Both Lancashire and the SCR are running NHS Test Bed programmes.

### Private sector collaborative R&D

- Research intensive companies already interacting with HE sector, with a combined turnover of circa £1bn and 6,000 employees.
- In 2014, BAE Systems managed overall research and development (R&D) investment of £902m, including £63m of its own funds.
- Siemens has invested £3.2m in funding research at TUOS since 2009, with a further £3.6m of in kind contributions and a further £8.3m in funding for collaborative research.
- Rolls-Royce is a lead partner in the University of Sheffield's AMRC with Boeing.
- Significant and growing cluster of innovative design and manufacturing companies co-located with innovation assets within the Advanced Manufacturing Innovation Districts.

<sup>3</sup>REF 2014 results:results.ref.ac.uk, Research income: HESA research income for 2014-15, from HEIDI.

<sup>4</sup>SciVal (Elsevier), Field Weighted Citation Impact for publications between 2011 and 2016 as at Aug 2016income for 2014-15, from HEIDI.

<sup>5</sup>Internal figures from University of Sheffield, UCLan and Lancaster University

<sup>6</sup>Private correspondence with BAE systems and Siemens

## Growth opportunities

The complete integration of digital technologies into manufacturing – Industry 4.0 – will increase productivity and add value for those firms able and willing to change. Future high value manufacturing will be digital, reconfigurable, customisable and will capture more of the value chain, blurring the line with services.

Sensors and networks will gather and integrate information from products in use (“internet of things”). Data analytics, machine learning and artificial intelligence (AI), machine/human interfaces, automation and robotics will underpin these trends, and issues of cyber- security will be more pressing. Innovation in materials and processes will be driven by the need to reduce weight, substitute scarce materials, and design for recycling (*the “circular economy”*). Customisation will be enabled by additive manufacturing (e.g. 3D printing), and these new technologies will demand new, optimised materials.

These technologies will transform the high value manufacturing sectors that the audit region specialises in. These sectors also offer great potential for market growth.

- In **aerospace**, demand for air travel will grow, and new aircraft will need to be greener, quieter and more economical. The development of increasingly autonomous unmanned aerial vehicles (UAVs) presents a growing niche opportunity.
- In **nuclear energy**, the challenge lies in ensuring that a supply chain with high value UK content delivers the UK’s new nuclear build programme. The development of a UK driven small modular reactor programme is a particularly important prospect that would create substantial value for manufacturers in the region.
- In **rail**, the global market is projected to grow at 2.7% pa worldwide, with an expansion of high speed rail in the UK and elsewhere driving the adoption of new technologies, such as the need for lightweighting and advanced control systems.
- In **healthcare technology**, there is intense pressure to develop technological solutions to the problems of supplying healthcare affordably to an ageing population.

## Gap analysis

The audit has revealed gaps and shortcomings in the region’s skills and innovation landscape. Some of these have emerged from data analysis, while others have recurred in industry consultations.

- Although there are some highly innovative companies, the overall level of private sector R&D is too low. This needs to be recognised and addressed.
- The excellence of the region’s translational research institutions is acknowledged, but they should operate at a larger scale across the whole audit region to meet fully the demands and needs of the regional industrial base.
- There is a recognition of the excellence of the region’s academic research base, but more could be done to connect this to regional industry. Areas in which the research base should be further strengthened include data analytics and cyber-security as applied to manufacturing problems.
- There is a widespread consensus that skills remain a problem. This includes intermediate technical skills and graduate attraction and retention.

## ***Ambition, investment and growth opportunities***

The audit's conclusions on the region's strengths, the relevant technological and market opportunities, and its gaps indicate the steps that need to be taken to realise the vision of a high value manufacturing sector revitalised through innovation and skills. The overall goal is an Advanced Manufacturing Innovation Corridor in which the widespread adoption of Industry 4.0 and the embracing of innovative materials and processes creates value and drives productivity growth.

### **Capital science and innovation infrastructure**

Establish the **Northern Advanced Manufacturing Innovation Corridor** from Sheffield's Advanced Manufacturing Innovation District to the Lancashire Advanced Manufacturing Innovation District at Salmesbury, anchored by the Northwest AMRC. Further capital science and innovation infrastructure opportunities include:

- Lightweighting Centre
- Robotics and Autonomous Systems translational research centre
- Data analytics for manufacturing, through strengthened links to the national Alan Turing Institute.

### **Talent attraction, development and retention**

A **pan-Northern skills programme** to support the requirements of advanced manufacturing businesses and complementary aligned sectors for the emergent new skills needs of Industry 4.0. This will enthuse the younger generation and create a talent pipeline, tackle challenges around replacement demand for highly technical skills, mitigate risks around an ageing workforce and help to retain talent in the North.

**New enterprise support** will be provided for advanced manufacturing, and linked industries will create the ambitious entrepreneurs and high growth businesses of the future

### **Northern innovation support**

**Collective innovation programmes** (advanced manufacturing, digital, data science, cyber-security, robotics, eco-innovation, health and care, management, innovation) to link SME and corporate agendas to build resilient supply and value chains.

Develop a **Northern Powerhouse nuclear supply chain productivity/innovation support programme** for the **Small Modular Reactor** (nuclear) growth opportunity.

### **Northern Productivity Academy**

Establish a **Northern Powerhouse Productivity Academy** to drive the transformational leadership and management change required to make a significant impact on the region's productivity and innovation behaviours. This builds on Lancaster's involvement through its partnership with BAE Systems on the Government's Productivity Leadership Group and a pilot Leadership for Productivity Programme under development.

### **Support for internationalisation**

**Deliver support for internationalisation** exploiting regional HE and industrial networks and partnerships, working with the LEPs and UKTI etc.

Explore the potential for a Northern International Catalyst Programme building on Lancaster China Catalyst Programme, SCR internationalisation programmes.

## *Networking, collaboration, and the added value of the SIA process*

The SIA process has been a highly positive and successful one, with momentum and enthusiasm building over time as stakeholders have become more engaged and inspired. Partner representatives from across all of the pan-regional universities, and key RTOs, science parks, incubators, the NHS and industry have provided constructive 'check and challenge' throughout, whilst the assembled qualitative and quantitative data have ensured that the resulting SIA Framework is grounded in robust evidence.

In addition to the bottom-up data analyses and desk-based review work that has informed the region's science and innovation thinking, the open and inclusive process used to shape the SCR and Lancashire SIA Framework has itself delivered significant added value. Existing linkages have been enhanced, new relationships developed, and 'hidden' synergies and complementarities brought to the fore.

Whilst we must recognise that the collaborative working and common approaches evident across the two sub-regions are still very much in their infancy, the level of trust, shared commitment and ambition that now exists augurs well for both the two sub-regions (SCR and Lancashire), as well as the wider Northern Powerhouse. Indeed, it has become clear across the region's different partnership structures through recent discussions that the SIA process has already started to deliver beneficial impacts on the localised innovation systems and we are confident that it will leave a lasting legacy of a more outward-facing growth agenda.

Notable aspects of our SIA process include:

- The first Northern Advanced Manufacturing Innovation Corridor collaboration - a new partnership formed between the Universities of Lancaster and Sheffield to establish a Northwest AMRC on the Salmesbury Enterprise Zone (EZ) in Lancashire, focused on supporting advanced manufacturing supply chains and driving productivity improvements in regional SMEs
- Agreement by BAE Systems, Rolls Royce, Siemens and the Lancashire LEP to fund a pilot Leadership and Management Programme under the Productivity Academy for mid-small supply chain businesses to be delivered by Lancaster University in early 2017
- SIA consultation workshops held in Lancashire in January and August 2016, with a mix of university, industry and Research and Technology Organisation (RTO) representatives in attendance. The events provided excellent networking opportunities and there was strong support for the emerging SIA framework
- A programme of primary research through in-depth consultations with 24 major advanced manufacturing firms and representative bodies active within the two sub-regional geographies. This work has helped to promote and champion existing growth plans, identify cross-sectoral synergies, common challenges and opportunities
- A meeting with the Greater Manchester and East Cheshire SIA leadership team held in July 2016 in Manchester, to share lessons and good practice, as well as exploring opportunities for increased joint-working in relation to high value manufacturing and Industry 4.0 thinking.
- Discussion with colleagues in the Midlands Engine SIA in September 2016 regarding the complementarities in advanced manufacturing broadly and particularly in rail, where the existing Doncaster involvement in the Birmingham-based National College for High Speed Rail could be a nucleus for further collaboration in Next Generation Transport.





*This report was produced for the Department for Business, Energy and Industrial Strategy. The consortium overseeing the audit represents the key innovation partners in the Sheffield City Region and Lancashire Local Enterprise Partnership areas.*





# South West England and South East Wales Science and Innovation Audit Summary Report

A Science and Innovation Audit Report sponsored by  
the Department for Business, Energy and Industrial Strategy

## Introduction

The South West England and South East Wales Science and Innovation Audit (SWW-SIA) evaluated scientific excellence and growth potential across one of the most vibrant regions of the UK, with world class universities, large-scale, high-tech industry clusters and a very high proportion of innovative SMEs.

The SIA identified areas of world-leading research and innovation in the SWW, including aerospace, microelectronics, energy generation, environmental technologies, and digital systems.

The principal conclusion of the SIA is that better integration of these scientific and industrial strengths could be driven by a series of strategic investments in **Advanced Engineering** and **Digital Innovation**. These will provide cross-cutting research expertise, skills development and create a new innovation ecosystem to stimulate long-term economic growth and job creation across the SWW.

The potential of the SWW can be realised through specific investments with immediate impact, coupled to a long term plan, embedded in the Government's Industrial Strategy. This plan will have strong industry pull and the engagement of both large industry and the SME community.

The SIA process has provided real impetus and cohesion across the SWW, which offers great benefits to be realised by systematic and sustained investment by Government in partnership with the private sector.

In the immediate-term, the SIA underlined the importance of new capabilities afforded by the *Compound Semiconductor Applications Catapult*, and recommended fully funding the proposed *Institute for Advanced Automotive Propulsion Systems (IAAPS)*, and *Composites Excellence – with National Composites Materials Centre*. These selective investments are driven by existing industrial need, in which government can play a transformative role, resulting in a highly visible return on investment.

**The SWW-SIA spans the South West of England (Cornwall & Isles of Scilly, Gloucestershire, Heart of the South West, Swindon & Wiltshire, and West of England LEPS) and South East Wales.**

## Our vision

The SWW region can lead the UK and compete with the world in advanced engineering and digital innovation, driving growth of its' large-scale aerospace, microelectronics, high tech marine engineering and energy sectors, while creating new industries across environmental technologies, digital health, and the creative sector. Strong integration of scientific excellence within its universities and institutes, with an innovative industrial sector with a thriving SME population, will lead to substantial job creation and sustained economic growth.

## Key Strengths

Advanced Engineering Key Strengths	
The largest aerospace sector in the UK – home to 14 of 15 largest aerospace companies in the world <sup>1</sup> , with associated research excellence.	High tech marine and marine renewables resources, with infrastructure unique in the UK, alongside pioneering R&D capacity.
High Value Engineering Design and System Integration skills, encompassing whole structure, sub-structure and propulsion integration.	Composites and advanced manufacturing (National Composites Centre, part of the HVM Catapult).
Technical expertise, know-how and scientific excellence in Hydrogen / Fuel Cells technology.	Strong nuclear energy expertise and associated skills development capability and infrastructure.
Emerging technology cluster in distributed energy systems and smart grid technology.	Microelectronic, photonic and semiconductor expertise (Compound Semiconductor Applications Catapult).

Digital Innovation Key Strengths	
Home to the largest silicon design cluster outside of the USA <sup>2</sup> , and a recognised powerhouse of electronics and computing in industry and in academia.	Expertise in smart cities, digital media, autonomous systems, risk, resilience and digital health in which the SWW is the national exemplar.
Pioneering technology expertise in cloud computing; communications; Internet of Things; cyber security; sensors; virtual and augmented reality; robotics / autonomous systems; microelectronics; wireless technologies; data analytics; vision; remote sensing; satellite applications; high performance computing; and quantum engineering.	Home to the most productive and second largest digital economy cluster in the UK. <sup>3</sup>  World leading expertise in the fields of natural hazards, climate change, marine science and broader environmental sciences; combined with the data modelling and analytics expertise, capability and assets required to translate this into profitable intelligence.

## Growth Opportunities

### Advanced Engineering Growth Opportunities

To grow the Aerospace and related Advanced Engineering sectors (including automotive, nuclear, space, marine and marine renewables and microelectronics) by building critical mass in the SWW to exploit synergies in skills, high-level training, research expertise and supply chains. The aerospace industry's continued success depends on investing in high value design capability in SWW and UK-wide.

To pioneer the diversification of composite materials capabilities to secure the value chain of advanced manufacturing technology in the UK, including SWW strengths in developing technologies to deliver low-carbon technologies and the circular economy, e.g. composites waste management.

To integrate the diverse SWW energy capabilities to:

- capitalise on the SWW's unique natural environment and marine renewables assets to establish a world-leading marine renewables test-bed for commercialisation
- capitalise on the economic growth potential of nuclear new-build and fleet operation in the SWW, by integration of the existing cluster of industrial and academic expertise
- create a large-scale distributed energy demonstrator from cities to peripheral rural areas, incorporating nuclear, marine renewables and hydrogen fuel cells, thereby positioning the UK at the forefront of new energy technologies.

### Digital Innovation Growth Opportunities

To integrate digital innovation investments to drive forward development of smart cities, towns and rural environments in the SWW.

To work with the private sector to integrate world-leading environmental and marine science expertise and analytics capabilities to address global market failures in the provision of environmental risk management services and skills; enhancing resilience to environmental change and driving new £ multi-billion opportunities for economic growth.

To drive new industry creation through investment in a network of Digital Innovation Hubs to integrate researchers, entrepreneurs, students, industry and users to create new technologies, policies, practices, business models, and businesses for the digitalised society of tomorrow.

## Gap Analysis

Gap analysis		
Future State We want to be...	Current State We have...	Next Actions / Proposals We need to...
<p>The global leaders in</p> <ul style="list-style-type: none"> <li>– High Value Design</li> <li>– Systems Integration</li> <li>– Composites</li> </ul> <p>to maintain and grow our global aerospace cluster and wider Advanced Engineering sector.</p>	<ul style="list-style-type: none"> <li>– A world-leading aerospace cluster</li> <li>– An advanced engineering supply chain</li> <li>– An Advanced Propulsion Centre Spoke</li> <li>– The National Composites Centre (part of HVM Catapult).</li> </ul>	<p>Secure investment for:</p> <ul style="list-style-type: none"> <li>– High Value Design</li> <li>– Automotive Propulsion Systems (IAAPS)</li> <li>– Composites Excellence</li> <li>– Marine / Marine Renewables prototype commercialisation.</li> </ul>
<p>At the forefront of creating:</p> <ul style="list-style-type: none"> <li>– the world's new industries in Digital Innovation</li> <li>– resilience in our smart cities, towns and rural environments.</li> </ul>	<ul style="list-style-type: none"> <li>– Pioneering expertise in smart cities, digital media, autonomous systems, digital health, and environmental science</li> <li>– Underpinning expertise in microelectronics, wireless technologies, data analytics, vision, remote sensing, satellite applications, high performance computing, cloud computing, quantum engineering, cyber security and virtual reality.</li> </ul>	<p>Secure investment for Digital Innovation Hubs in:</p> <ul style="list-style-type: none"> <li>– cloud, cyber security, communication and smart cities, digital media, autonomous systems, digital health</li> <li>– environmental risk and innovation</li> </ul> <p>Investigate future Hubs such as Industry 4.0.</p>
<p>The world's first cluster dedicated to compound semiconductors.</p>	<p>UK Government commitment to siting the new Compound Semiconductor Applications Catapult in the SWW.</p>	<p>Exploit the Catapult to grow the SWW industry cluster, attracting further capital investment, jobs and growth.</p>
<p>Exemplars at meeting industry needs for graduate and PhD level workforce.</p>	<ul style="list-style-type: none"> <li>– A strong pipeline of graduates who take up roles in these industries</li> <li>– Current doctoral training capacity.</li> <li>– Government initiatives to fund level 5-7 Degree Apprenticeships.</li> </ul>	<ul style="list-style-type: none"> <li>– Secure investment in further, collaborative doctoral training with industry to address skills gaps.</li> <li>– Establish multi-university Degree Apprenticeships to address skills gaps.</li> </ul>
<p>An integrated and well-networked region of academic, public sector, and industry (large and SME) partners with a shared vision for economic success.</p>	<p>A well-evidenced track record in building effective, distributed clusters.</p>	<p>Build on the momentum of the SIA by maintaining and growing productive relationships in a more sustainable framework.</p>

## Key ambitions / proposals

The SWW requires sustained government support in **Advanced Engineering** and **Digital Innovation**. A series of specific investments<sup>4</sup> have been identified that will increase regional

GVA and drive increased productivity across a much wider geographical area of the UK. In the immediate-term, the SIA recommends capitalising on the *Compound Semiconductor Applications Catapult*, and fully funding the proposed *Institute for Advanced Automotive Propulsion Systems (IAAPS)*, and *Composites Excellence – with National Composites Materials Centre*.

The SIA identified a very strong industry-pull to better integrate existing activities and to create new capacity in Advanced Engineering and Digital Innovation. This will drive significant added-value across the industries reviewed in the SIA. **Business Cases are available for each proposal**. Figure 1 shows, schematically, the Advanced Engineering and Digital Innovation inter-connected hubs and linked assets of the SWW.

### Advanced Engineering

The SIA recommends investment in **High Value Engineering Design and Systems Integration Capabilities**, through establishing a design and demonstration centre of excellence focused on design integration capabilities and rapid prototyping. Although initially focused on aerospace, the related sectors of automotive, space, nuclear, marine engineering / energy and microelectronics would benefit in future phases. A Bristol-based Advanced Engineering Campus will be the catalyst. This has very strong industry support and significant commercial leadership.

### Digital Innovation

The SIA recommends establishing an integrated network of Digital Innovation Hubs to connect academic and industry expertise. Phase one will establish a Bristol-based **Digital Innovation Hub** combining world-leading expertise in underpinning technologies (such as cloud computing, communications, and cyber security) with SWW specialisms in Smart Cities, Autonomous Systems and Digital Health. The first specialist Hub should be the **Institute for Environmental Risk and Innovation**, focused on utilizing analysis of future climate and weather risks to provide resilient infrastructure, innovation and economic gain. This should be situated on the new Global Environmental Futures Campus linked to the Met Office in Exeter. Initial investments should be followed by a series of further Hubs to co-ordinate digital innovation, enabling the SWW to be a leader in Industry 4.0.

## Networking / collaboration

The SWW-SIA was led by the GW4 group of universities, along with the Universities of Plymouth and the West of England, and brought together a consortium of over 100 organisations<sup>5</sup> – from across business (53%), research organisations, Local Enterprise Partnerships and local government. This truly represents a coordinated effort across the SWW region. The Steering Group, chaired by Prof. N. J. Talbot FRS, met on four occasions to provide overarching governance and ownership of the process, under the leadership of Prof. Dame Glynis Breakwell DBE DL FAcSS.

Representatives from GKN Aerospace, Compound Semiconductor Centre Ltd., Johnson Matthey, the Met Office and Oracle chaired the SWW-SIA Theme Review Panels (over 50% business membership); which provided leadership, expert guidance and advice throughout the process. 190 people registered / attended stakeholder events (37% from business, 37% universities, 11% LEPs/LAs, 8% business intermediaries, 7% catapults / other research); and further meetings and surveys engaged 100s more, particularly SMEs.<sup>6</sup>

This extensive engagement enabled the SWW-SIA to genuinely understand the importance of geography, synergies, structures, and opportunities in the SWW. Figure 1 shows a map of the SWW showing schematically the Advanced Engineering and Digital Innovation assets that span the region.

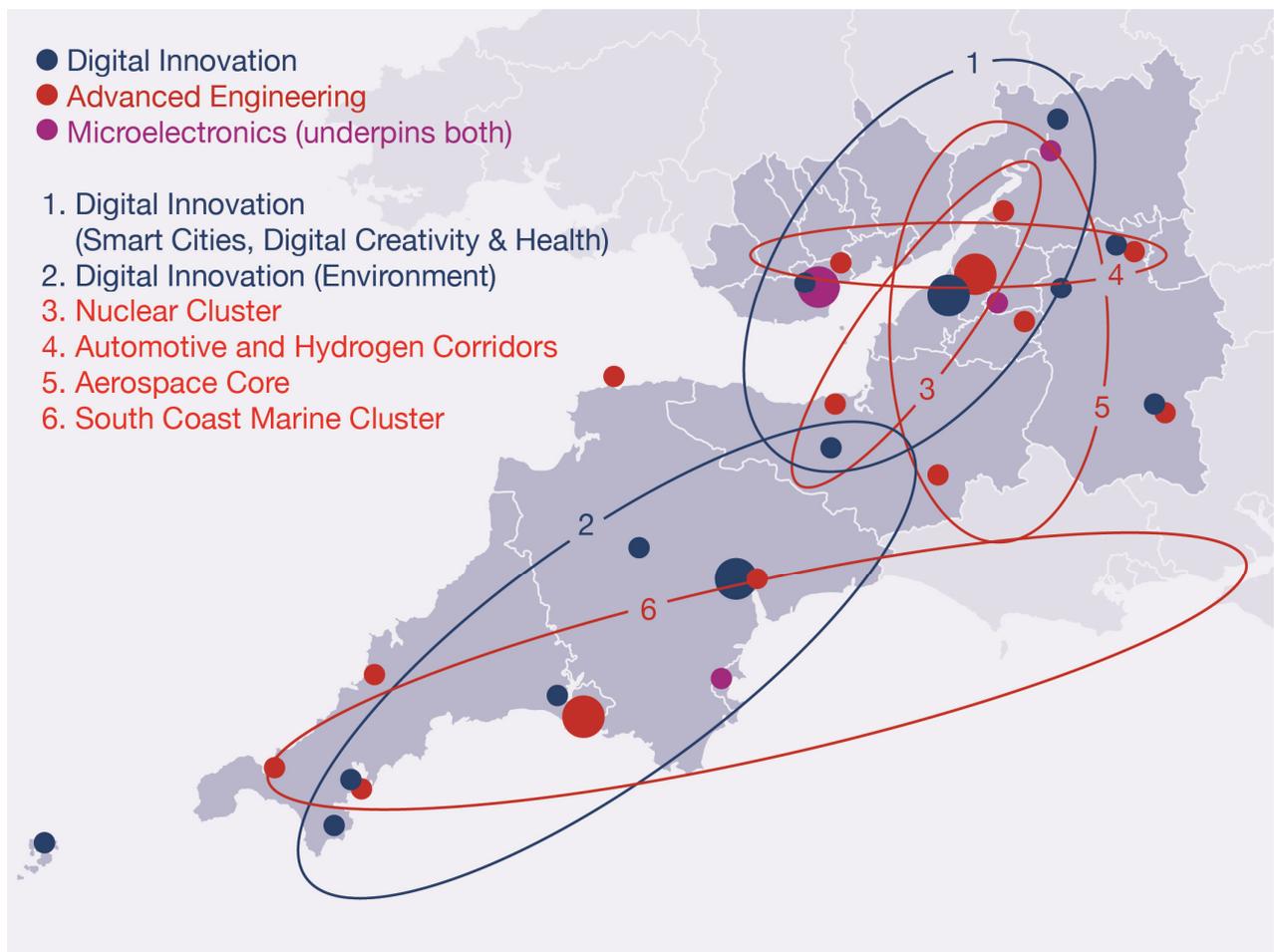


Figure 1. Map of the South West England and South East Wales Science and Innovation Audit region – showing Advanced Engineering and Digital Innovation inter-connected hubs ○ and linked assets ● (Note: schematic – size does not reflect scale.)

The SWW-SIA has been a catalyst for regional collaboration and innovation. Figure 2 shows the impact and added value of undertaking the SWW-SIA, and as a result we will:

- achieve a step change in collaboration, with a newly articulated focus around Advanced Engineering and Digital Innovation
- build on synergies identified to develop a cohesive plan for the future of the SWW
- undertake a coordinated initiative to bring together innovators in academia and industry – driven by industry pull
- fully engage with and contribute to the Government's Industrial Strategy
- accelerate innovation through scientific excellence across SWW for the benefit of the region and the UK
- Empower the region's LEPs to take on a leadership role to implement the SIA.

The SIA Steering Group will meet in December 2016 to ensure momentum in implementation of the SWW-SIA.

Figure 2. Quotes showing the impact and added value of undertaking the SWW–SIA.



## References

- <sup>1</sup> <http://www.pwc.co.uk/industries/aerospace-defence/top-100-aerospace-companies-2014.html>
  - <sup>2</sup> Silicon Southwest <http://ubic.org.uk/siliconsouthwest/>
  - <sup>3</sup> Various, including: [http://www.techcityuk.com/wp-content/uploads/2016/02/Tech-Nation-2016\\_FINAL-ONLINE-1.pdf](http://www.techcityuk.com/wp-content/uploads/2016/02/Tech-Nation-2016_FINAL-ONLINE-1.pdf)
  - <sup>4</sup> SWW-SIA Annex N – provides outlines of planned investments
  - <sup>5</sup> SWW-SIA Annex A – Membership of Steering Group
  - <sup>6</sup> SWW-SIA Annex A – Theme Panel membership and stakeholder event attendees
-