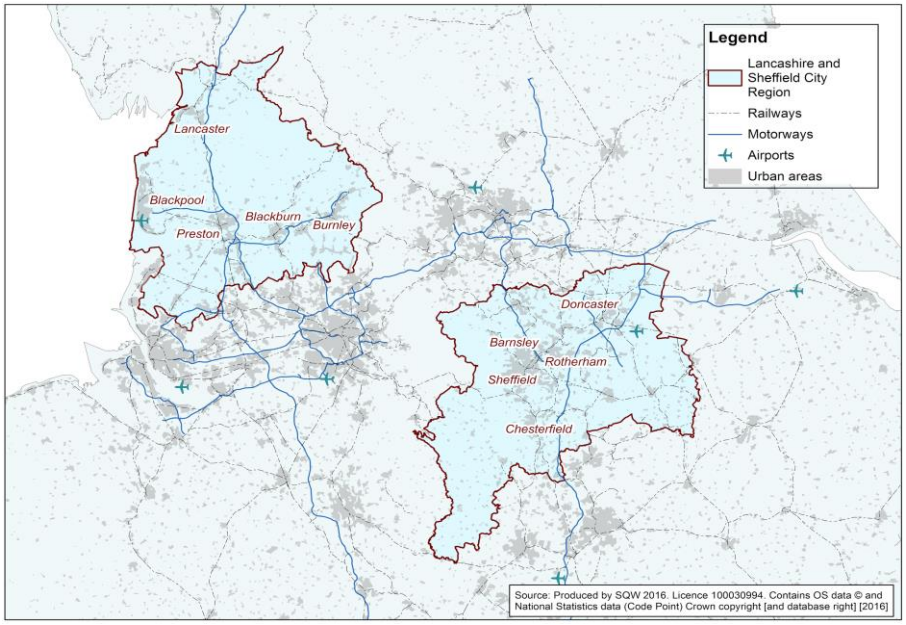
Driving productivity growth through innovation in high value manufacturing

Executive Summary



The Lancashire/Sheffield City Region Science and Innovation Audit covers two Local Enterprise Partnership areas, Sheffield City Region and Lancashire. The SIA has been carried out by a consortium representing those LEPs, and including Industry and academic leaders

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

1. Introduction and Context

The context for this audit is set by a UK-wide economic problem; stagnation of productivity growth since 2008. The audit region contributes to this; regional productivity is well below the average for England.

This regional productivity gap has been attributed to three factors[1]: 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 LEP areas comprising the Audit region share a specialism in high value manufacturing, 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 highly 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 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 the 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. There is an opportunity is to invest in key schemes which will allow the region to deliver innovation to allow the UK to maximise the benefits of Industry 4.0.

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

2. 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 the existing outstanding translational research assets (£207m Research Grant income per year)
- join up the skills landscape across the region from apprenticeships to 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 already 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 and leadership and management.

Strategic delivery of the vision will build on initiatives already taking place within and between the two LEP areas, and based on the ***Advanced Manufacturing Innovation District (AMID) concept***, which recognises the need for a whole place based 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 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 UCLAN's Engineering Innovation Centre, is the first substantial project which will begin to achieve this and which 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 and retained to 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

3. Key strengths

HE Research base	Public sector R&D facilities
• 6 Universities, £207m of grant research income (2014), 90% of research internationally recognised or better. • Tripling of Engineering research income in the decade to 2014-15. • 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.*	• 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.
Translational research centres	**Private sector & collaborative R&D**
• Translational research centres bring together academia 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) • ESPRC 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 Uni Health Innovation Campus (£167m capex, planned)	• 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 R&D investment of £902 million, including £63 million 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

4. Growth opportunities

The complete integration of digital technologies into manufacturing – *Industry 4.0* – will increase productivity and added 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, further blurring the line between manufacturing and services.

Sensors and networks will gather and integrate information from products in use (*"internet of things"*). Data analytics, machine learning and 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 is 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 grown 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.

5. 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 yet more could be done to connect this to regional industry. Areas in which the research base should be further strengthened include data analytics and cybersecurity 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.

6. Ambition, investment and growth opportunities

The Audit's conclusions on the region's strengths, the relevant technological and market opportunities, and remaining 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 embrace of innovative materials and processes creates value and drives productivity growth.

Table 1 sets out investment which is now required to achieve phase one of this change.

Capital science and innovation infrastructure	**Talent attraction, development and retention**
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: • Light-Weighting Centre, • Robotics and Autonomous Systems translational research centre • Data analytics for manufacturing, through strengthened links to the national Alan Turing Institute	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	**Northern productivity academy**
Collective innovation programmes (in advanced manufacturing, with digital, data science, cyber-security, robotics, eco-innovation, health/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.	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 our 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 Higher Education 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.	

Table 1: Investment required to deliver growth opportunities

It will be important to develop the next phase of development in a way that stresses its pan-northern and national significance, and reinforces the Government's innovation and productivity agendas. The Advanced Manufacturing Innovation Corridor will need to be linked to wider *Industry 4.0* agendas across the Midlands Engine, North East Wales (Deeside), South Wales and the Bristol City Region – helping to reposition the UK as a global leader in advanced manufacturing. This should be a key part of the development of a National Industrial Strategy.

7. Networking, collaboration, and the added value of the Science and Innovation Audit process

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, which 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 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 & Management Programme under the Productivity Academy for mid-small supply chain businesses to be delivered by Lancaster University in early 2017
- SIA consultation workshops were held in Lancashire in January and August 2016, with a mix of university, industry and 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 on the 21st July 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.

In short, 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 enthused. Partner representatives from across our universities, 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.