Applied digital technologies in North East advanced manufacturing



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

Science and Innovation Audit partners:

North East Local Enterprise Partnership
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In Autumn 2015, the UK Government announced Science and Innovation Audits (SIAs) to catalyse a new approach to regional economic development. SIAs involve local consortia analysing regional strengths and identifying mechanisms to realise their potential. In the North East of England, a consortium was formed in 2017 to examine our strengths in applied digital technologies in advanced manufacturing. This report presents the results including a broad-ranging analysis of the North East's capabilities, the challenges and the substantial opportunities for future economic growth.

1. Introduction to the region and SIA area

Key messages

The focus of this Science and Innovation Audit (SIA) is applied digital technologies in advanced manufacturing in the North East of England. Within advanced manufacturing, the SIA has focused on automotive manufacturing, chemicals manufacturing and pharmaceutical manufacturing.

The chosen theme reflects the importance of manufacturing to the North East economy with manufacturing accounting for 14.3% of the region's Gross Value Added (GVA) and 10.6% of employment.

The application of digital technologies to advanced manufacturing products and processes is considered to have the potential to generate significant improvements in productivity, maintain the sector's competitiveness, and support growth.

This SIA has set out to explore the opportunities provided by the adoption of digital technologies by advanced manufacturing businesses in the North East for both the advanced manufacturing and digital sectors.

Introduction

The focus of this Science and Innovation Audit (SIA) is applied digital technologies in advanced manufacturing in the North East of England. Within advanced manufacturing, the SIA focused on automotive manufacturing, chemicals manufacturing (including bulk chemicals, speciality chemicals, polymers and plastics, and materials) and pharmaceutical manufacturing.

The adoption of applied digital technologies, frequently characterised as Industry 4.0, has the potential to allow more customised, complex and timely manufacturing as well as to underpin the future productivity and competitiveness of manufacturing.

"Industry 4.0 refers to the next stage in manufacturing that uses new, digital and real-time approaches to production to meet demand for more complex, individualized and digitally enabled products.

The focus of Industry 4.0 is on process improvements to help advanced manufacturing businesses become more productive and deliver new products."[1]

However, the success of this process will depend on the linkages between the digital and advanced manufacturing sectors. With long-established and export-focused advanced manufacturing sectors and a fast-growing digital sector, the North East is potentially well-placed to take advantage of the opportunities generated by Industry 4.0.

1 https://www.gtai.de/GTAI/Navigation/EN/Invest/Industries/Industrie-4-0/Industrie-4-0/industrie-4-0-what-is-it.html

SIA vision and hypotheses

The vision for the SIA was:

To explore and set out opportunities to make more of the North East of England's excellence in digital and data-based technologies, key manufacturing sectors and networks for translation and solution development.

Applying digital solutions to the wider economy is an essential element in maintaining long-term competitiveness of key export-led sectors and continuing to support growth in the digital sector. The North East is the natural location for this.

The hypotheses for the SIA were:

The North East has a niche area of strength bringing together digital processes and design that matches with the needs of manufacturing sectors as set out in Industry 4.0.

The North East is home to key manufacturing clusters in automotive manufacture, chemicals manufacture and pharmaceutical manufacture that would enhance exports through adoption of Industry 4.0.

The North East has the infrastructure, networks and relationships in place to enable translation and adoption between sectors but that these require further development.

The partners involved in the SIA were:

North East Local Enterprise Partnership

Tees Valley Combined Authority

Centre for Process Innovation

Digital Catapult North East and Tees Valley

Durham University (on behalf of the North East universities)

First for Pharma

High Value Manufacturing Catapult

North East Automotive Alliance

North East England Chamber of Commerce

Sunderland Software City

Zero Carbon Futures

Overview of North East

The North East has a population of 2.6 million individuals[2] and over 74,000 businesses.[3] In 2016, the region produced £50.7 billion of goods and services.[4] The region includes a mix of cities and large towns including (Newcastle, Sunderland, Durham and Middlesbrough), urban and rural areas with economic activities concentrated around the coastline and rivers.

Key features of the North East economy include:

- A vibrant business base with over 10,000 business births in 2016[5] and similar levels of business survival[6] and business growth[7] to the UK as a whole.
- A fast growing digital business base[8] alongside established advanced manufacturing businesses.[9]
- Lower levels of productivity[10] and wages[11] than across the UK as a whole.
- High levels of goods exports and growing service exports.[12]
- A stable population but with low levels of population growth and an ageing workforce.[13]

More detail on these are given in Appendix 1. On many of these indicators, significant progress has been made over the last five years, with the gap between the North East and the UK reducing on many measures.

Figure 1.1: Map of North East of England

2 Data from Population estimates – local authority based by single year of age (Nomis). Data for 2016.
3 Data from UK Business Counts (Nomis). Data for 2017.
4 Data from Regional Gross Value Added (balanced approach) (ONS). Data for 2016.
5 Data from Business demography (ONS). Data for 2016.
6 Data from Business demography (ONS). Data for 2013 business births (survival at 1, 2 and 3 years).
7 Enterprise Research Centre (2017) UK Local Growth Dashboard.
8 TechNation Report (2018).
9 Data from Business Register and Employment Survey (BRES) (Nomis). Data for 2016.
10 Data from Subregional productivity: Labour productivity indices for UK NUTS2 and NUTS3 subregions (ONS). Data for 2016.
11 Data from Annual Survey of Hours and Earnings (ASHE) (Nomis). Data for 2017.
12 Data from Regional Trade Statistics (HMRC); and Regionalised Estimates of UK Service Exports (ONS). HMRC Data for 2017. ONS data for 2011 to 2015.
13 Data from Population estimates – local authority based by single year of age (Nomis) and Population projections – local authority based by single year of age (Nomis). Population estimate data for 2016. Population projection data for 2016 to 2026.

Importance of manufacturing to the North East

Manufacturing plays an important role within the North East economy, accounting for 14.3% of the region's GVA[14] and 10.6% of employment.[15] In 2017, the North East exported £12.9 billion of goods, including £7.4 billion of machinery and transport and £2.8 billion of chemicals (including pharmaceuticals).[16] Over the last 10 years, the manufacturing GVA of the North East has grown by 19.6%, slightly below the UK rate of 26.9%.[17] Goods exports from the North East have also been increasing – with the value of exports increasing from £11.8 million in 2013.[18] As with GVA, this is a slightly lower rate of increase in goods exports than the UK as a whole (9.1% compared to 11.5%). Despite growth in output and exports, employment in the sector has fallen by 21.8% over the last 10 years.[19]

The North East's manufacturing firms are concentrated in a number of specialist, high value advanced manufacturing sectors. The manufacturing sub-sectors that make the largest contribution to the North East's GVA are:

Manufacture of coke, refined petroleum and chemicals	Manufacture of fabricated metal products	Manufacture of motor vehicles	Manufacture of machinery and equipment	Manufacture of pharmaceutical products

All of these sub-sectors are overrepresented in the North East economy, compared to the UK, with location quotients (LQs) of between 1.6 and 2.5. The theme of this SIA (applied digital technologies in advanced manufacturing with a focus on automotive manufacturing, chemicals manufacturing and pharmaceutical manufacturing) has been chosen to reflect the importance of manufacturing in general and these sub-sectors in particular to the North East economy.

Figure 1.2: Contribution of selected manufacturing sub-sectors to North East GVA, 2016

SIC	Name	GVA (£ million)	% of North East GVA	LQ (compared to UK)
19-20	Manufacture of coke, refined petroleum and chemicals	1,109	2.2	2.5
25	Manufacture of fabricated metal products	887	1.8	1.8
29	Manufacture of motor vehicles	868	1.7	2.1
28	Manufacture of machinery and equipment	716	1.4	2.3
21	Manufacture of pharmaceutical products	590	1.2	1.6
C	Manufacturing	7,246	14.3	1.4

Source: Regional Gross Value Added (balanced approach) (ONS)
Note: Location quotients (LQ) measure the geographic concentration of industries. They can be calculated for a wide variety of indicators – most commonly employment, businesses or GVA. Using GVA as an example:
- A value of 1 means that the area has the same share of GVA in the industry as its share of national GVA.
- A value greater than 1 means the region has a higher share of GVA in the industry than its share of national GVA.

14 Data from Regional Gross Value Added (balanced approach) (ONS). Data for 2016.
15 Data from Business Register and Employment Survey (Nomis). Data for 2016.
16 Data from HMRC Regional Trade Statistics (HMRC). Data for 2017.
17 Regional Gross Value Added (balanced approach) (ONS). Data for 2006 and 2016.
18 Data from HMRC Regional Trade Statistics (HMRC). Data for 2013 and 2017. HMRC have revised the methodology for calculating Regional Trade Statistics. Whilst data is available for pre-2013, this is calculated using a different methodology.
19 Annual Population Survey – Workplace Analysis (Nomis). Data for 2007 and 2017. The Annual Population Survey has been used as changes there have been various changes to the main UK business surveys over the last 10 years leading to discontinuities in the data.

Applying digital technologies to advanced manufacturing

Applied digital technologies with the potential to impact on the North East's advanced manufacturing sector include:

Connected Factory

Connected machines, sensors and devices can enable manufacturers to eliminate defects. Examples of this include collecting data through in-vehicle diagnostics and smart packaging used in the administration of drugs.

Bringing together the North East automotive and medicine manufacturers, our digital sector's expertise in data analytics and the opportunities arising from the proposed North East 5G test-bed provides a significant opportunity to deliver productivity growth through the Connected Factory. Facilities such as the proposed Centre of Excellence in Sustainable Advanced Manufacture (CESAM) (discussed later in report), will allow manufacturers to test technology and get it 'line-ready' without disrupting existing operations.

Connected Supply Chain

Developments such as the proposed North East 5G test-bed will enable the North East's supply chains to become more connected than ever before. Manufacturers and suppliers will be able to share live data tracking orders and the physical movement of components allowing production to be rescheduled and automatically communicated allowing logistics to be more efficient reducing inventories, lead times, production sequencing and changes to requirements such as component size or consumer customisation.

Virtual reality and augmented reality

The North East's digital sector has a strong cluster of leading virtual and augmented reality developers (such as Zerolight) which creates opportunities for advanced manufacturing firms in the region to make use of these technologies. For example, virtual reality and augmented reality could be used to provide technical guidance or instructions, with live data and the simulation of manufacturing processes to prove concept, test and capture data to support decision making.

Using North East digital businesses to address manufacturing needs

There is a wide range of digital businesses located within the North East. The distinctiveness of the North East offer is three-fold, with the skills and capacities particularly relevant to manufacturing; strong clusters with established relationships and a cross-sector framework for support which benefits from proximity to enable long-term relationships and frequent meetings

Through the SIA process we have identified examples of existing collaborations within the area between digital businesses and advanced manufacturers. Businesses already active in this space in the North East include hedgehog labs in Newcastle, who are actively engaging with other sectors to support growth.[20]

This activity can have a positive ripple effect across others, demonstrating a value in clusters where expertise and capacity can be developed at a scale to enable new ideas to be developed, shared and trialled. This co-location approach can stimulate stronger innovation linked to both formal and informal networking.

The Innovation SuperNetwork[21] acts as a catalyst for cross-sector activities organising and stimulating addition formal and information networking opportunities.

This is supported by a programme of challenges which specifically bring together different companies from different sectors to develop solutions.

This is supported by the smaller scale of the North East economy which leads to increased potential for long-term links and supports partnership working. In addition to this internal advantage the presence of clusters of activity also has potential to draw in external partners with relevant skills and interests.

20 https://blog.hedgehoglab.com/
21 https://supernetwork.org.uk/

Links to other SIAs

In developing this SIA, links have been made to a number of other SIAs being undertaken in this wave.
We have also built on the work undertaken in previous rounds of SIAs. Details of the relevant SIAs are given below

Northern Powerhouse - Chemicals and process science (Wave 3)	This SIA has been led by Tees Valley Combined Authority and Durham University. There is a high level of overlap with this SIA. Members of the applied digital technologies SIA consortium have been involved in the chemicals and process science SIA and vice-versa, ensuring consistency. Going forward, there is potential for shared projects to take forward the recommendations from both SIAs.
Northern Powerhouse - Health Research – Utilisation of Data and Precision Medicine (Wave 3)	Led by The Northern Health Science Alliance (NHSA), this SIA has covered the whole of the Northern Powerhouse area. Areas of potential overlap have been avoided with the applied digital technologies SIA focusing on pharmaceutical manufacture rather than broader health issues.
Offshore Renewable Energy (Wave 2)	Both the North East LEP and Tees Valley Combined Authority were part of the steering group for this SIA. Due to the depth of coverage, the applied digital technologies SIA has not considered advanced manufacturing within the offshore renewable energy sector. However, the issues in relation to adoption of digital technologies are likely to be similar to the advanced manufacturing sectors considered in this SIA and businesses from the subsea and offshore energy sector are likely to benefit from similar types of intervention.
Innovation South (Wave 2) and Edinburgh City Region (Wave 1)	Two previous SIAs have considered the digital sector with reference to its role in growing the economy. This SIA builds on the lessons learnt in these two previous SIAs. The specific focus of this SIA has been the application of digital technologies to specific advanced manufacturing sectors which were not the focus of the two previous SIAs.

2. Excellence in science and research

Key messages

The North East has a wide range of science and research assets including specialisms in subject areas that are relevant to the SIA. These include various engineering subjects, information and communications technologies, and chemistry and materials sciences.

Going forward, it will be important to build on and strengthen the linkages between these assets and the advanced manufacturing and digital business base in the SIA area.

Research is also being undertaken by a wide range of businesses in the North East. The evidence on the businesses that are research active, business R&D spend and in relation to patents filed suggests that a large proportion of the research activity being undertaken by businesses in the North East is in SIA sectors. This provides a strong basis to build upon.

Introduction

This section sets out the North East's strengths in science and innovation. The focus is on identifying those areas that the North East has been successful in securing research funding and where the research being undertaken is most highly rated. Patents and the number of research-active organisations are also considered.

Research quality

Details of the submissions made to the Research Excellence Framework (REF) 2014 in Science, Technology, Engineering and Mathematics (STEM) subjects by the North East's five universities (Durham, Newcastle, Northumbria, Sunderland and Teesside) are given in Appendix 2. Reflecting the diversity of the research being undertaken in the North East, there were submissions across all STEM subject areas. Seven subject areas are of potential interest to this SIA – biological sciences; clinical medicine; aeronautical, mechanical, chemical and manufacturing engineering; chemistry; computer science and informatics; electrical and electronic engineering, metallurgy and materials; and general engineering.

- North East universities submitted 1,430 outputs and 384 full-time equivalent (FTE) researchers for consideration in subjects that are potentially of relevance to the SIA theme.
- In addition, 1,060 doctoral degrees were awarded in these subject areas between 2008 and 2012.

Combined, this suggests there is a significant volume of research being undertaken in the North East on topics allied to the SIA theme.

Turning to the quality of the submissions, the subjects with the largest proportion of research rated as 4* (defined as being of a quality that is world-leading in terms of originality, significance and rigour) were:

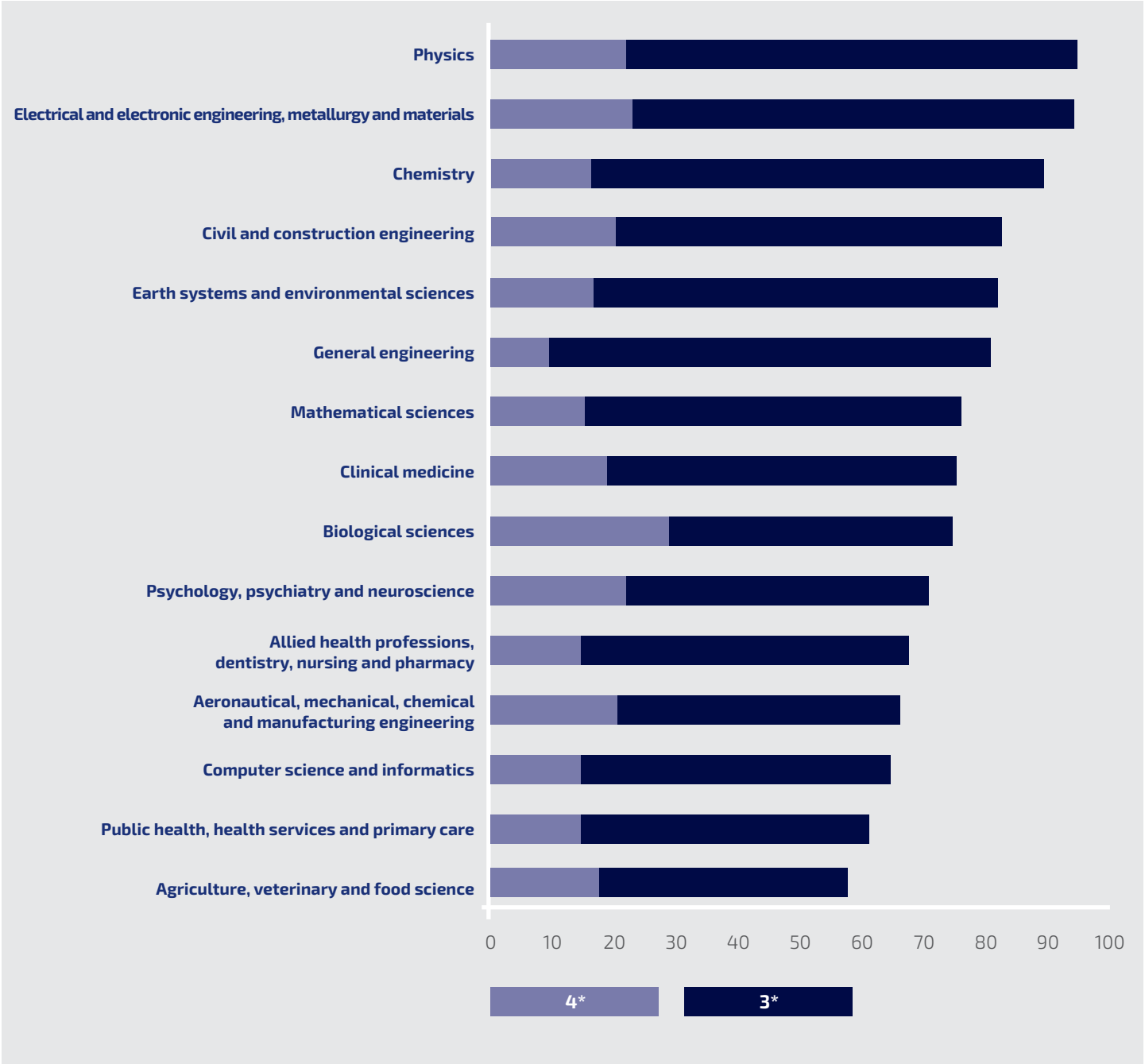
- Biological sciences (28.9% defined as 4*)
- Physics (21.8%)
- Psychology, psychiatry and neuroscience (21.7%)
- Aeronautical, mechanical, chemical and manufacturing engineering (20.1%)
- Civil and construction engineering (19.7%).

Broadening the measure out to those that were ranked at either 3* (defined as quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence) or 4*, a slightly different picture emerges with:

- 94.2% of physics research
- 93.9% of electrical and electronic engineering, metallurgy and materials research
- 88.9% of chemistry research
- 81.7% of civil and construction engineering
- 81.3% of earth systems and environmental sciences and
- 80.4% of general engineering being undertaken in the North East rated at 3* or 4*.

Whilst some of the subjects that are relevant to the SIA have a high proportion of research that is rated highly, the performance of some others is more modest. Comparisons with overall UK performance and data on performance by individual institution is given in Appendix 2.

Figure 2.1: % of research in each category rated 4* or 3*, higher education (HE) institutions in North East region, REF 2014



The Witty Review[22] examined the quality of research across a broad range of strengths. North East universities were in the top 20 for research publications for 11 subjects:

- Advanced materials and nano-technology (Durham, 16th)
- Automotive (Newcastle, 18th)
- Agri-technology (Durham, 17th; Newcastle, 18th)
- Agri-science (Newcastle, 18th)
- Big data (Newcastle, 7th)
- Energy storage (Newcastle, 7th; Durham, 9th)
- Life sciences (Newcastle, 14th)
- Offshore wind (Northumbria, 19th; Durham 3rd)
- Oil and gas (Durham 11th; Newcastle 7th)
- Regenerative medicine (Newcastle, 18th)
- Satellites (Durham, 2nd).

In addition, the Review flags the Institute for Automotive and Manufacturing Advanced Practice at the University of Sunderland as an example of research excellence in a non-research intensive university. Most of these are linked to one or more of the sectors in scope for this SIA – and a number of others relate to energy which is an important sector for the region but has not been included as it was covered in the Wave 2 Offshore Renewable Energy SIA.

Research funding

Given the timescales that it can take for research to be published and the infrequency of the REF (with the next REF scheduled for 2021), it can take time for emerging areas of excellence to come forward. For this reason, it is valuable to also look at research funding as this can give an indication of areas where the NE is developing a specialism. In total, organisations in the North East secured £933.11 million in funding from the UK Research Councils and Innovate UK between 2007 and 2017, across 2,530 projects.

- The Engineering and Physical Sciences Research Council (EPSRC) is the most important funder with an investment of £345.65 million across 617 projects.
- The next largest funders were the Medical Research Council (MRC) and the Biotechnology and Biological Sciences Research Council (BBSRC).

A full breakdown of funding from the UK Research Councils and Innovate UK is provided in Appendix 2.

Looking at the research funding awarded between 2007 and 2017 to North East based organisations, the subject areas that secured the most funding from the UK Research Councils and Innovate UK were:

- Energy (with 79 projects securing £46.2 million)
- Information and communications technologies (134 projects; £40.5 million)
- Astronomy – observation (58 projects; £29.9 million)
- Civil engineering and built environment (46 projects; £28.7 million).

As the volume of funding can be heavily influenced by national priorities, it is worth also examining the subject areas where the North East has secured a larger proportion of available funding than if funding was distributed evenly across the country. This is measured using a location quotient (LQ). The subject areas with the largest LQs are:

- Astronomy, theory – 6.95
- Environmental engineering – 5.75
- Civil engineering and built environment – 3.58
- Astronomy, observation – 3.07
- Energy – 2.57
- Geosciences – 2.40

22 Witty, A. (2013) Encouraging a British Invention Revolution:Sir Andrew Witty's Review of Universities and Growth. Final Report and Recommendations. Department for Business, Innovation and Skills.

It is notable that whilst many subjects that relate to the SIA are overrepresented compared to the UK, the overrepresentation tends to be small (e.g. 1.07 for information and communications technologies, 1.25 for materials sciences, etc.).

Figure 2.2: Top 20 research subjects by funding awarded, North East region, 2007 to 2017

Source: Compiled by Technopolis based on RCUK Gateway to Research

The 2014 REF collated data on higher education research income from international sources.

- Between 2008 and 2012, North East universities secured £96.8 million in international income.
- The subject areas securing the largest amount of international income over this period were clinical medicine; aeronautical, mechanical, chemical and manufacturing engineering; and physics.
- The subject areas where the North East's universities are overrepresented in securing international income are civil and construction engineering; aeronautical, mechanical, chemical and manufacturing engineering; physics; earth systems and environmental sciences; and agriculture, veterinary and food science.

Whilst some subject areas relevant to the SIA appear to have been successful in securing international income, others are less well represented. The full breakdown of international funding is given in Appendix 2.

Research active organisations

569 organisations participated in 4,018 Research Councils and/or Innovate UK-funded projects between 2007 and 2017. The North East accounted for 2.9% of UK participations (compared to 4.0% of population and 2.9% of GVA).

The organisations in the North East with the largest number of participation over that period were:

- Newcastle University (1,392 participations)
- Durham University (1,062)
- University of Northumbria at Newcastle (193)
- Centre for Process Innovation Ltd (132)
- University of Teesside (53)
- Newcastle City Council (31)
- Northumbria Water Ltd (30)
- Thomas Swan and Co Ltd (27)
- Pragmatic Printing Ltd (20)
- Epigem Ltd (15)
- DuPont Teijin Films UK Ltd (15)
- AkzoNobel UK (13)
- Prozomix Limited (13)
- Tyne and Wear Archive and Museums (13)
- Kromek (13)
- Polyphotonix Ltd (12)
- Green Structures Ltd (11)
- Nissan Motor Manufacturing (UK) Ltd (11).

Other organisations that participated in UK Research Council or Innovate UK-funded research and that are relevant to the theme of this SIA include:

- Monitor Coatings Ltd (9)
- Proctor and Gamble Technical Centres Ltd (9)
- Fujifilm Diosynth Biotechnologies (8)
- Orla Protein Technologies Ltd (7)
- Avecia Biologics Ltd (6)
- North East Process Industry Cluster (6)
- OSYS Technology Ltd (6).

There were 755 participations by organisations in the North East in EU Framework Programme projects between 2007 and 2017. The organisations with the largest number of participations are:

- University of Newcastle upon Tyne (344)
- University of Durham (182)
- University of Northumbria at Newcastle (24)
- Centre for Process Innovation Ltd (21)
- Teesside University (16)
- National Renewable Energy Centre (13).

Others participants that are relevant to the theme of this SIA include:

- Epigem Ltd (5)
- Dupont Teijin Films UK Ltd (4)
- Prozomix Limited (4)
- Safinah Limited (4)
- Fujifilm Diosynth Biotechnologies Ltd (3)

The data on research active organisations suggests a large number of organisations in the applied digital technologies sector or one of the three advanced manufacturing sectors the SIA is focusing on are research active. There will also be many others that are innovation active but have not secured funding through these public sources. Another source of information on research active organisations is the Global Research Identifier Database (GRID). The list of North East-based organisations listed on GRID is given in Appendix 3.

Business expenditure and employment on research and development

Expenditure on research and development (R&D) by North East region businesses was £306 million in 2015.[23]

- This is 1.5% of total UK expenditure on R&D by businesses.
- £1.4 million was spent on R&D by North East region businesses for every 10,000 adults in 2015. This compared to £4 million across the UK as a whole and is about a sixth of the rate of expenditure in the best performing region which is the East of England.

4,000 full-time equivalents were employed in R&D in businesses in the North East region.[24]

- This is 2.0% of total UK employment in R&D in businesses.
- There were 19 individuals employed in undertaking R&D within businesses in the North East region for every 10,000 adults. This is lower than other regions and devolved administration and less than half of the UK average of 39.

Combined, these suggest that the North East's businesses are less likely than those in other areas to be research active.

Figure 2.3: Expenditure (£ million) and employment by UK businesses on performing R&D by region and devolved administration, 2016

	Expenditure (£ million)	Expenditure (£ million) per 10,000 adult population	Employment (000s)	Employment per 10,000 adult population
East	4,393	8.9	37	75
South East	4,693	6.4	42	58
West Midlands	2,303	4.9	19	41
East Midlands	1,655	4.3	17	44
UK	22,224	4.2	210	39
North West	2,346	4.0	17	29
South West	1,500	3.3	18	40
London	2,296	3.3	20	29
Northern Ireland	481	3.3	7	47
Scotland	1,072	2.4	12	27
Yorkshire and Humberside	750	1.7	10	23
Wales	435	1.7	5	20
North East	302	1.4	4	18

Source: Business Expenditure on Research and Development (BERD) (ONS)

Looking at business expenditure on R&D (BERD) in the North East in more detail:

- Two-thirds (66.9%) of expenditure was in manufacturing – £202 million. This is slightly below the UK (69.4%) rate. This is a surprising finding – given that manufacturing accounts for a larger proportion of the North East's GVA and employment.
- The product groups within manufacturing that account for the largest proportion of the North East's BERD were:
  - Chemicals (£98 million; 33% of North East BERD). This category includes pharmaceuticals
  - Mechanical engineering (£40 million; 13%)
  - Other manufacturing (£28 million; 9%)
  - Transport (£17 million; 6%)
  - Electrical machinery (£15 million; 5%)

The North East is overrepresented compared to the UK in relation to mechanical engineering BERD (with this accounting for 13% of North East BERD compared to 5% of UK BERD) and chemicals BERD (33% compared to 23%). This suggests that the SIA areas are particularly important to the North East's business R&D.

23 Business Expenditure on Research and Development (BERD) (ONS)
24 Business Expenditure on Research and Development (BERD) (ONS)

Intellectual property

Analysis by Technopolis of patents within the EPO-PATSTAT Worldwide Patent Statistical Database (Spring 2017 version) for which geo-location is available has generated estimates that, between 2004 and 2016, there were just over 18,000 patent applications from the North East, submitted by just over 3,000 unique applicants . The largest categories of applicants (by World Intellectual Property Organization sector) were:

- Basic materials chemistry (accounting for 20.9% of patents filed from the North East)
- Organic fine chemistry (9.4%)
- Electrical machinery, apparatus, energy (9.2%)
- Chemical engineering (9.1%).

All of these are relevant to the topic of this SIA. Other categories that are relevant to the SIA include:

- Biotechnology (6.5%)
- Other special machines (6.4%)
- Macromolecular chemistry, polymers (5.8%)
- Mechanical elements (5.8%)
- Medical technology (5.6%)
- Machine tools (4.3%)
- Pharmaceuticals (4.3%)
- Surface technology, coating (3.7%)
- Materials, metallurgy (3.3%)
- Transport (2.6%)
- Computer technology (2.5%)
- Engines, pumps, turbines (2.4%)
- Analysis of biological materials (1.9%)
- Digital communication (1.0%)
- IT methods for management (0.5%)
- Telecommunications (0.4%).

Combined, this suggests that the vast majority of patent applications from the North East were either directly or indirectly linked to either applied digital technologies or one (or more) of the advanced manufacturing sectors being examined by this SIA. 72.5% of applicants were businesses, 16.4% were individuals, 8.8% were universities and 2% were hospitals.

North East businesses that made more than 10 (geo-located) patent applications during this period include:

- Wellstream International Limited
- Kromek Limited
- Draeger Safety UK Ltd
- Husqvarna UK Limited
- Fujifilm Diosynth Biotechnologies UK Limited
- Pii Limited
- CMP Products Limited
- Soil Machine Dynamics Limited
- Jackel International Limited
- IHC Engineering Business Limited
- EBAC Limited
- Nomad Spectrum Limited
- Pearson Engineering Limited.

Some of these are within the advanced manufacturing sectors that are the focus of this SIA, with most of the others within the broader advanced manufacturing sector. Combined with the subject area focus outlined above, overall, the evidence indicates that the majority of the patent activity in the North East is strongly aligned to the SIA theme.

3. Innovation strengths and growth points

Key messages

Automotive, chemicals and pharmaceutical manufacturing are all overrepresented within the North East's business base and employment base, with 215 businesses and 26,500 employed. Many more will be engaged in the supply chain for these businesses.

There are over 2,600 businesses within 'computer programming, consultancy and related activities' and 'information service activities', employing almost 13,500. Due to issues in defining the digital sector, this is likely to represent an underestimate.

Combined, automotive, chemicals and pharmaceutical manufacturing contributed £2.2 billion to North East GVA in 2016, with digital contributing a further £722 million.

Key businesses include:

- Automotive – Nissan, ZRF-TW and Hyperdrive
- Chemicals – AkzoNobel, SABIC and INEOS
- Pharmaceutical – MSD, GSK and Glythera
- Digital – Zerolight, Hedgehog Labs and Sage

The presence of strong local supply chains and supporting sectors linked to the manufacturing sectors provides an opportunities to introduce new approaches through the manufacturing process.

Introduction

This section sets out the size and contribution of businesses in the North East's advanced manufacturing and digital sectors and considers supply chain linkages. Before examining the data, it is worth highlighting how the sectors have been defined:

- For advanced manufacturing, data is presented for businesses that have identified their main activity as automotive, chemicals and pharmaceutical manufacturing. There will be many more businesses in the region that play a role in the supply chain for these industries – for example, manufacturers of batteries.
- Due to the rapid development of the digital sector, Standard Industrial Classifications (SIC) which are used to categorise and publish data on a sectoral basis are generally considered a poor fit to the sector. The SIC codes 'computer programming, consultancy and related activities' and 'information service activities' have been used as a best fit – but these are likely to exclude many relevant activities.

Automotive manufacturing

85 enterprises

15,000 employed

£868 million GVA

Chemical manufacturing

105 enterprises

9,000 employed

£1.1 billion GVA*

Pharmaceutical manufacturing

25 enterprises

2,500 employed

£590 million GVA

Digital

2,620 enterprises

13,450 employed

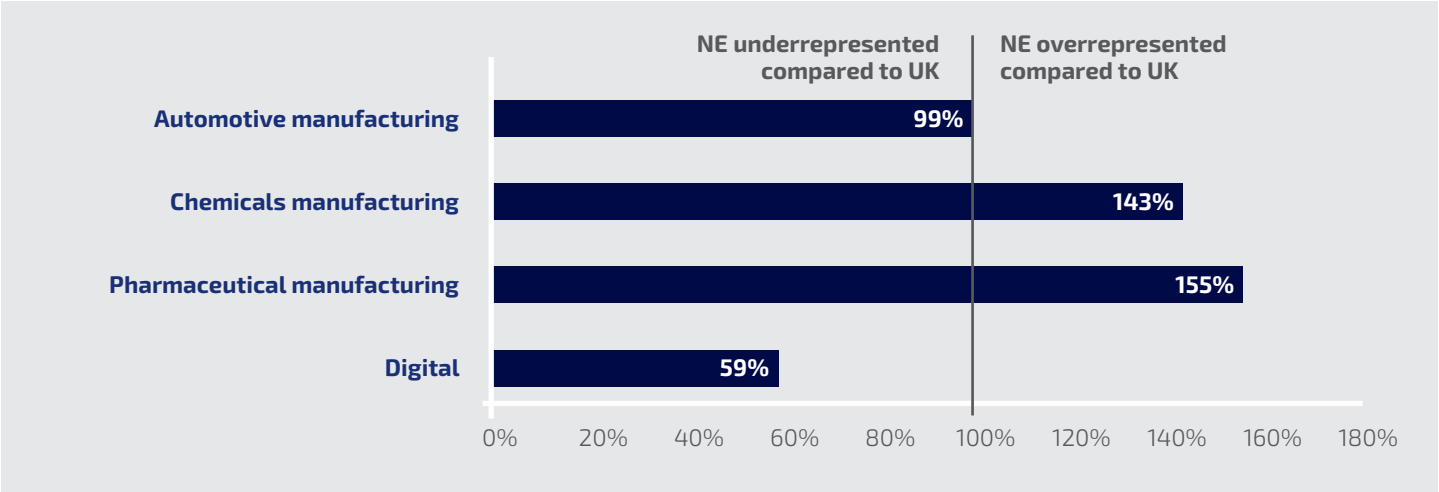
£722 million GVA

*Includes manufacture of coke and refined petroleum products

Enterprises

Overall, the number of enterprises in the advanced manufacturing sector is small with 215 across the automotive, chemicals and pharmaceutical manufacturing industries combined. This, in part, reflects the size profile of businesses in this sector, with businesses more likely to be large businesses (250+ employees) than in other sectors. In contrast, there are a large number of enterprises in the digital sector – 2,620 – with the vast majority of these micro-enterprises (0-9 employees). Enterprises in the chemicals and pharmaceutical manufacturing sectors considered in this SIA are overrepresented in the North East compared to the UK as a whole (with location quotients of above 1), whilst enterprises in the digital sector (broadly defined) are underrepresented.

Figure 3.1: How does the number of enterprises in North East advanced manufacturing and digital sectors compare to the UK (UK=100)?



Source: UK Business Counts - Enterprises (Nomis)
Note: Data for 2017.

Key businesses within the advanced manufacturing and digital sectors are set out below.

Figure 3.2: Key businesses in advanced manufacturing and digital in the North East

Automotive manufacturing	Chemicals manufacturing	Pharmaceutical manufacturing	Digital
Nissan	AkzoNobel Performance Coatings	Accord Healthcare	Accenture
Komatsu	Applied Graphene Materials	Aesica Pharmaceuticals	Aspire
Caterpillar	Banner Chemicals	Arcinova	Atom bank
Cummins	Biffa Polymers	Biosignatures	Bede
Calsonic Kansei	CF Fertilisers	Fujifilm	Datatrial
Gestamp-Tallent	Chemoxy International Ltd	Diosynth Biotechnologies,	Eutechnyx
Unipres	Conoco Philips	GlaxoSmithKline	Hedgehog Labs
Vantec Europe	Dupont Teijin Films	Glythera	Hewlett Packard
ZF-TRW	Exwold Technologies	High Force Research	IBM
R-Tek	Fine Organics	MSD	Leaf.fm
BorgWarner	Greenergy International Ltd	Orla Protein Technologies	Leighton Group
AVID technology	High Force Research	Piramal Healthcare	NBS
Hyperdrive	Huntsman Chemicals	Sterling Pharna Solutions	Nomad Digital
	INEOS	Wasdell	Ontrac
	Johnson Matthey	Merck Sharp & Dohme Limited	Opencast
	Kilfrost		Orangebus
	Lotte Chemical UK		Orchard
	Lucite International		Palringo
	Micropore		Performance Horizon group
	Procter and Gamble		Red Hat
	Plaxica		Sage plc
	SABIC Pertrochemicals		Scott Logic
	Thomas Swan		Tombola
	Tracerco		Turnitin
	Victrex		Ubisoft
			Worldpay
			Zerolight

The supply chain networks in the North East are strong within the automotive manufacturing sector with a clear relationship between original equipment manufacturers (OEMs), Tier 1 and Tier 2 suppliers, actively supported by the local cluster organisations to ensure that the demand for high-quality, just-in-time components are met. This requires a significant element of coordination and proximity to suppliers clustered in dense locations around major infrastructure. This demand has increased over time and has stimulated the development of the International Advanced Manufacturing Park (IAMP) site to enable more effective clustering of supply chains with additional connectivity and modes of transport to support increasingly sophisticated logistics.

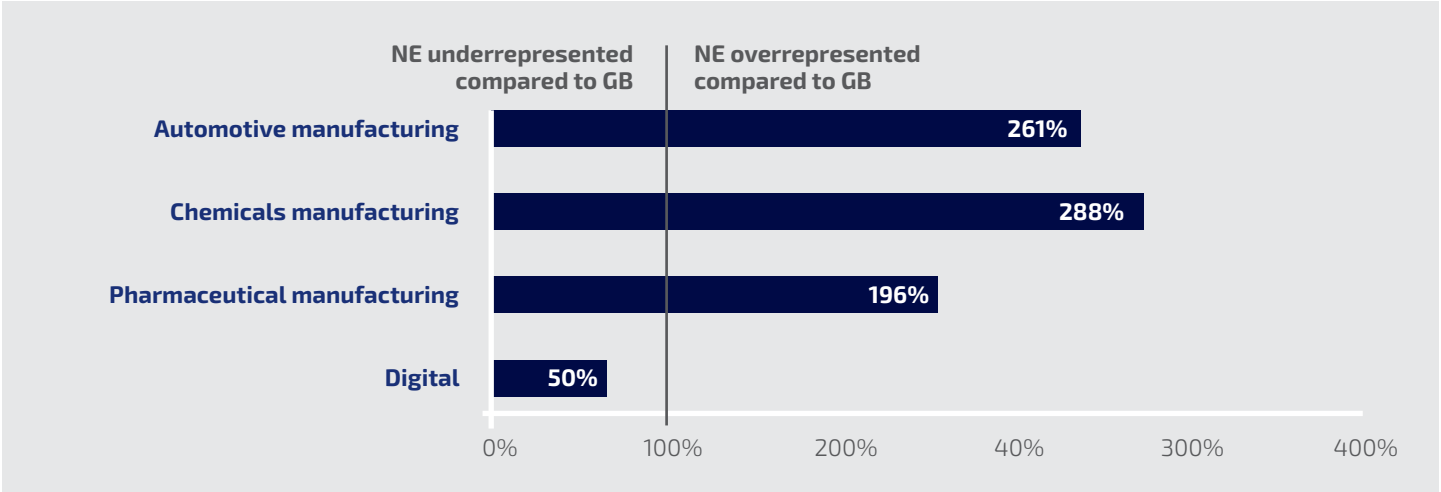
A different picture emerges in relation to the supply chains for chemicals and pharmaceutical manufacturing due to a lesser requirement for components and inputs to be sourced locally and the nature of the products being manufactured. There is scope for local supply chains to provide other services or inputs such as packaging, electronics or transportation. As set out in the Chemicals and Process Science SIA, there is scope for increased on-shoring for the chemicals sector to improve resilience and support the shift to the circular economy.

Distinct to the direct manufacturing and packaging supply chains noted above, the local presence of digital companies that can support the integration and adoption of digital technologies is a clear local advantage. Despite the often borderless nature of digital companies the specific capabilities available locally and the benefits of proximity for innovation result in an advantage for the North East. Proximity and established relationships do facilitate a level of trust required to facilitate open innovation.

Employment

Looking at employment, a similar picture emerges with employment in automotive, chemicals and pharmaceutical manufacturing overrepresented in the North East and employment in the digital sector underrepresented. Employment in the three advanced manufacturing sectors being considered is 26,500 – with additional large numbers employed in the supply chain. Automotive manufacturing employs the largest number at 15,000, with 9,000 in chemical manufacturing and 2,500 in pharmaceutical manufacturing. Despite being underrepresented within the North East economy, the digital sector accounts for almost 13,500 jobs.

Figure 3.3: How does employment in North East advanced manufacturing and digital sectors compare to the Great Britain (GB=100)?



Source: Business Register and Employment Survey (Nomis)
Notes: 1. Data for 2016
2. UK data not available.
3. BRES covers all businesses registered for VAT and/or PAYE. 'Employment' includes employees plus working owners (for example, sole proprietors and partners).

GVA

As outlined in Section 1, manufacturing is the sector that makes the largest contribution to the North East's GVA, contributing £7.2 billion in 2016. Manufacturing accounts for 14.3% of the North East's GVA, a much larger proportion than in the UK as a whole (10.1%). Looking at the advanced manufacturing sectors examined in this SIA:

- Automotive manufacturing contributed £868 million
- Pharmaceutical manufacturing contributed £590 million.

Data is not available for chemicals manufacturing – as this is grouped alongside the manufacture of coke and refined petroleum. This sector contributed £1.1 billion to the North East economy.

Looking at digital:

- Computer programming and consultancy contributed £629 million to North East GVA in 2016.
- Information service activities contributed £93 million in the same time period.

Both are under-represented compared to the UK, with location quotients of 0.52 and 0.56 respectively.

Examining scale and contribution in more depth:

Pharmaceutical manufacturing

In relation to pharmaceutical manufacturing, two other sources provide an indication of the size and scale of the sector and its supply chain links.

The Office for Life Sciences (OLS) Strength and Opportunities 2017 report[25] provides insights into the size and composition of the sector and its supply chain.

- There were 12 companies in core biopharma[26] in the North East in 2017, with a turnover of £260 million and employing just under 1,850.
- There were a further 61 companies in biopharma service and supply,[27] with a turnover of £340 million and employing almost 2,300.

The Office for Life Sciences Strength and Opportunities report includes data for the digital health segment. The digital health segment includes "companies whose main activity involves the application of digital technology to deliver health or wellbeing services and products. These companies typically provide software or other IT related products. Companies that earn most of their revenue from equipment are not included". In 2017, the North East had:

- 8 digital health sites
- 136 employees
- Turnover of £10 million.

Research undertaken by First for Pharma, CPI and the North East LEP[28] estimated that employment in the North East's pharmaceutical manufacturing sector was between 4,300 to 5,300.

- This is equivalent to between 12% and 15% of Great Britain's pharmaceutical manufacturing employment. The proportion of manufacturing process will be higher as the Great Britain employment figure includes all activities undertaken by pharmaceutical manufacturers.
- Using multipliers, it was estimated that the North East's pharmaceutical manufacturing sector supports a further 9,100 to 11,400 jobs in their supply chain and 5,400 to 6,700 jobs through the spending by their employees and their supply chain's employees.

25 Bioscience and health technology database: annual report 2017. Strength and Opportunity 2017: the data behind the charts (Office for Life Sciences)
26 Defined by OLS as "Core Biopharma includes all companies whose business involves developing and/or producing their own pharmaceutical products – from small, R&D-focused biotechs to multinational Big Pharma."
27 Defined by OLS as "Biopharma Service & Supply comprises companies that offer goods and services to Core Biopharma companies. These include contract research and manufacturing organisations, suppliers of consumables and reagents for R&D facilities, providers of specialist analytical, IT, recruitment and logistics services as well as legal and regulatory expertise and finance companies specialising in biopharma investments."
28 First for Pharma, CPI and North East LEP (2017) Profile and Importance of the North East Pharmaceutical Manufacturing Sector: Growing Its Contribution.

Linkages between advanced manufacturing and digital businesses

Advanced manufacturing businesses

As part of the SIA, e-surveys of advanced manufacturing and digital businesses in the region were undertaken. Despite widespread promotion of these through relevant sectoral bodies and through social media, the numbers participating in the e-surveys was very low (with 13 manufacturing businesses, mainly in the automotive sector, and 12 digital businesses taking part). As such, the survey results reflect only a snapshot of activities, experiences and views within a very small number of businesses and should not be considered in any way representative.

In this section, we will set out the findings of the survey that we feel can add value to the SIA. In particular, as there is very limited data on the extent to which digital and advanced manufacturing businesses are working together or what support they need to facilitate linkages between them, the survey can provide some useful (if limited) insights into these topics.

Looking first at the advanced manufacturing businesses, all of the businesses that completed the survey reported they were already using digital technologies. However, in many cases digital technologies were being used by the business as a whole but not in their North East sites.

- The most commonly used technology was data analytics. This was being used by eight businesses – although only six were using at their North East sites.
- The Internet of Things (e.g. connected factory, connected supply chains, etc.) was being used by five businesses – but only two were using at their North East sites.
- Robotics used by four businesses – with all four using at North East sites.
- Only one business reported use of virtual reality, with none reporting they were using augmented reality.

The main drivers for adopting digital technologies within these businesses had been to:

- Reduce costs.
- Improve efficiency.
- Improve the quality of the product or to reduce faults.

In relation to linkages with digital businesses in the North East, around half had used the service of North East-based business to help with digital adoption. All of those that had used a North East-based business considered the service being based in North East important, mainly due to their closeness to the site. This was seen as important for a number of reasons including that it allows them to build strong working relationships, allows speed and responsiveness to site and that proximity is important for proof of concept projects.

The majority of the surveyed businesses had digital strategies, a digital champion and/or processes in place for identifying digital technologies. However, a much smaller proportion had strategies, champions or processes in place at their North East sites. Linked to this 'lack of digital strategy' was identified as the main barrier to adopting digital technologies at North East sites. Combined, these suggest action is needed to support the North East's advanced manufacturing businesses to understand the potential of digital technologies and/or to capitalise on these.

Looking forward, digital technologies that advanced manufacturing businesses in the North East said they were most likely to adopt at their North East sites over next two years were Internet of Things, data analytics and robotics.

The surveyed businesses were asked about the support they would most value in relation to adopting digital technologies. The supports that were most commonly identified were:

- Information on digital technologies and their potential applications.
- Help to access training for current staff to develop their digital skills.
- Help to assess the potential cost and benefits for their business.
- Increasing the availability of digital skills (through more college and university courses).

Digital businesses

The most common products and services offered by the digital businesses surveyed as part of the SIA were data analytics and Internet of Things products or services that are not specifically related to manufacturing processes. Whilst the majority of the surveyed clients served business clients, less than half had clients in SIA advanced manufacturing sectors.

The businesses identified the main barriers they faced in working with advanced manufacturing businesses as:

- A lack contacts or track record with advanced manufacturing businesses.
- A lack of understanding of the needs of advanced manufacturing businesses.
- A lack of awareness within advanced manufacturing businesses of the potential impact of adopting digital technologies.
- Confusion within advanced manufacturing businesses about most appropriate digital technologies for their business.

Looking forward

- Three businesses planned to develop data analytics products or services in the next two years.
- Two planned to develop Internet of Things products or services specifically related to manufacturing processes and two planned to develop other Internet of Things products and services (i.e. not specifically related to manufacturing processes).
- One planned to develop virtual reality products or services and one planned to develop augmented reality products or services.

However, despite most surveyed businesses having plans to develop new products or services, only one was developing a product or service directly targeted at one of the SIA advanced manufacturing sectors. This suggests more needs to be done to develop linkages between the sectors. Reflecting this, a number of different supports were identified as being potentially useful to them in helping them increase their sales to advanced manufacturing businesses including:

- Information on advanced manufacturing sectors and their needs.
- Improving access to finance to fund adoption of digital technologies by advanced manufacturing businesses.
- Facilitating linkages between digital businesses and advanced manufacturing businesses.
- Help to assess the potential scale of the market for their business in the advanced manufacturing sector.

Strategic commitment to SIA sectors

The North East has a long history of innovation and leading the development of new technologies, particularly in manufactured products. Whilst the North East's industries have changed over time, the focus on science and innovation as a source of competitive advantage has remained constant. Reflecting this, both the North East LEP and the Tees Valley Combined Authority have identified innovation as themes in their Strategic Economic Plans (SEPs). Both areas have also identified areas of opportunity/smart specialisation that they see as critical to growth. In both cases, advanced manufacturing and digital are identified.

Figure 3.4: Sectoral priorities of North East Local Enterprise Partnership and the Tees Valley Combined Authority

North East LEP	Tees Valley Combined Authority
Areas of opportunity • Tech North East – Driving a digital surge • Making the North East's future – Automotive and medicines advanced manufacturing • Health Quest North East – Innovation in health and life sciences • Energy North East – Excellence in subsea, offshore and energy technologies **Enabling services** • Financial, professional and business services • Transport and logistics • Education	**Innovation Strategy key growth sectors** • Advanced manufacturing • Process and energy • Healthcare • Digital **SEP cross cutting theme** • Circular Economy

Source: North East Strategic Economic Plan (North East LEP, 2017) and Tees Valley Strategic Economic Plan (Tees Valley Combined Authority, 2016)

Manufacturing and particularly advanced manufacturing is written throughout the strategic priorities for both the North East LEP and the Tees Valley Combined Authority. In addition to the focus on automotive, chemicals and pharmaceuticals highlighted in this SIA, wider manufacturing strengths in rail, sub-sea and offshore equipment, food and other goods are all present.

The development and use of data and digital technologies is also a major theme for both areas with significant investment having been made by both organisations into infrastructure (such as the BOHO development in Middlesbrough, Sunderland Software City and a range of start-up spaces in Newcastle) to enable businesses in this sector to grow and develop.

Similarly there is a shared interest in health and life sciences with both areas home to high performing NHS trusts, research facilities and a range of businesses operating in niche and emerging areas of health and life science such as photonics, formulation, smart packaging and around cells. This provides a wider context and set of assets that the pharmaceutical manufacturing sector can utilise.

In approaching the development of the SIA, the consortium has focused on those areas of particular strength where there has not already been an audit undertaken. The North East has already been involved or is involved with audits addressing important areas of the bio-economy, health and life sciences, materials and chemicals, offshore and subsea engineering and satellites and we do not wish to replicate these here. This SIA takes the opportunity to focus on the North East's distinctive strength in advanced manufacturing (with a focus on the automotive, chemicals and pharmaceutical manufacturing sectors) and the opportunities that the region's digital assets and business base provide in helping these sectors develop new sources of competitive advantage. This is a North East strength that has been so far unexplored through the SIA process.

4. National and international trends and size of global markets

Key messages

The main drivers for the adoption of digital technologies across automotive, chemicals and pharmaceutical manufacturing are:

- Reducing costs in an increasingly competitive global market
- Developing new products, with a particular focus on responding to changing consumer demands and changing regulation
- Managing risks – in particular in relation to supply chains.

There is no consensus on the potential value of the applied digital technologies to the automotive, chemicals and pharmaceutical industries. However, the estimates that do exist for individual markets (e.g. robotics for chemicals manufacturing) suggest a period of significant and substantial growth over the next five to 10 years.

There is a lack of evidence on the share of the applied digital technologies market in advanced manufacturing that is currently being captured by UK or North East businesses.

Introduction

This section sets out the current national and international market for applied digital technologies in the advanced manufacturing sectors of automotive, chemicals and pharmaceutical and the potential future development of these sectors. In particular, it examines global market size, the UK's position in the global market, barriers to growth and take-up and the main players in the market.

Automotive manufacturing

Global market size

Digital technologies can be applied in various aspects of the automotive production process. As such, there is no single piece of analysis that assesses the size of the market in this sector. Individual analyses provide estimates on the size of different market strands:

- Automotive robotics – Research and Markets examined the market for automotive robotics (which carry out tasks such as welding, assembly and material removal in automobile production). Their analysis suggests that the global automotive robotics market was worth $5.07 billion in 2016 and was forecast to be worth $8.44 billion by 2021.[29]
- Connected cars – These are vehicles which are connected to mobile networks, enabling vehicles to maintain their own maintenance and operation and deliver greater comfort to passengers. According to Grant Thornton, the global market for connectivity components and services is currently €30 billion but is expected to reach €170 billion by 2020.[30]
- Digitalisation of automotive industry – In a manufacturing context, this covers activity such as the use of virtual reality and analytics to optimise material flow, testing new production methods on an alternative 'digital twin', and the use of sensors on machinery to help with plant maintenance. Analysis by KPMG indicates that by fully embracing such digitalisation, the automotive sector as a whole stands to gain £6.9 billion every year by 2035, leading to a GVA increase in the UK of £8.3 billion each year to 2035.[31]
- Internet of Things (IoT) in the automotive industry – Within a manufacturing context, this is likely to include elements such as connected factories and the use of sensors in the manufacturing process. Analysis by Statista indicates that worldwide, the automotive industry's revenue from IoT-related activity will reach $23.6 billion by 2025.[32]

The UK's position in the global market

Although there is little evidence concerning the North East's share of the global market for applied digital technologies in automotive manufacturing, KPMG research provides a picture of the UK's position. Their analysis suggests that Germany, the US and Japan are viewed as global leaders in the digitalisation of automotive manufacturing, having the most developed industrial digital applications, and being far more advanced in developing common standards across the industry. The UK is currently not seen as a leader in the digitalisation of automotive manufacturing, with the lack of a meaningful co-ordinated national strategy seen as a key contributor to this lag. However, it is considered to have the main ingredients to enable a rapid development of its market[33] while KPMG highlights the Nissan Sunderland Plant as being a particularly good UK example of plant automation, and obtaining and analysing plant data to predict production failures.[34]

29 Globe Newswire, 23 January 2018, Global Automotive Robotics Market 2017-2021: $8.44 Billion Industry 4.0 And Made in China 2025 Industrial Plans Opportunities. Internet, available at https://globenewswire.com/news-release/2017/01/23/909929/0/en/Global-Automotive-Robotics-Market-2017-2021-8-44-Billion-Industrie-4-0-And-Made-in-China-2025-Industrial-Plans-Opportunities.html (accessed 13 April 2018)
30 Grant Thornton (2017) India's Readiness for Industry 4.0: A Focus on Automotive Sector, p.18. Internet, available at https://www.gita.org.in/Attachments/Reports/India's%20Readiness%20for%20Industry%204.0.pdf (accessed 13 April 2018)
31 KPMG (2017) The Digitalisation of the UK Automotive Industry, p. 20. Available at https://www.smmt.co.uk/wp-content/uploads/sites/2/smmt_the-digitalisation-of-the-uk-auto-industry_kp-mg-apr-2017.pdf (accessed 13 April 2018)
32 Statista (2018) Internet of Things: automotive segment revenue worldwide in 2014 and 2024. Internet, available at https://www.statista.com/statistics/423083/iot-units-installed-base-with-in-automotive-segment/ (accessed 13 April 2018)
33 Grant Thornton (2017) India's Readiness for Industry 4.0: A Focus on Automotive Sector, p. 13
34 Ibid. p. 16

Within this, the Automotive Sector Deal's ambition to increase the value of UK content in domestically produced vehicles by 50% by 2022 coupled with Nissan's commitment to produce 600,000 vehicles per year (increasing from current rate of 500,000 per annum) presents a huge opportunity for North East suppliers. In addition, the North East's leading position in Electric Vehicle production coupled with increasing demand for Electric Vehicles presents an opportunity for the North East supply chain to further develop its market reach and scale. Research undertaken on behalf of the North East LEP[35] identified that the most important areas of innovation for the North East automotive manufacturing sector were:

- Real-time predictive data analytics.
- Connected real-time supply chain scheduling and demand data-driven supply chains.
- Connected factories including connected movable assets and automated supply chains.

It estimated that unlocking innovation in this area and getting businesses to adopt these digital technologies would increase productivity in technical disciplines by up to 50% and overall productivity by 5%. Building on the current work of the North East Automotive Alliance and the Centre of Excellence in Sustainable Advanced Manufacturing (CESAM), (both discussed in more detail in Section 5) is seen as critical to unlocking these productivity gains. Priorities for action include encouraging open innovation, reducing risks and costs of adopting digital technologies, working in partnership, improving information and support (for example on funding available) and putting in place the interventions required to develop the skills and training needed to take advantage of these technologies.

Market drivers

Existing analysis points to several factors driving global demand for applied digital technologies within the sector. The primary ones include:

- Desire for more connected supply chains – Automotive manufacturing is characterised by complex supply chains, requiring long lead-in times for production. Better managed supply chains can lead to cost reductions and quicker production rates. Consequently, there has been growing interest in the development of connected supply chains and partner system integration to enable greater data gathering and analytics. It is hoped that this data sharing will help reduce defects and speed up component, design and manufacturing processes.[36]
- Desire from OEMs to future-proof manufacturing facilities – As automobile original equipment manufacturers (OEMs) bring out new models and vehicles, they need to invest in new plants and technologies, either through retro-fitting or in completely new facilities. Digital automotive manufacturing factories are often more resource efficient than traditional ones. For instance, they can produce more variants on the same assembly line without major changeover costs. As OEMs look to develop or improve manufacturing facilities, they increasingly prefer digital factories, knowing that these will better help them meeting future manufacturing demands.[37]
- Rapid expansion in global connectivity – The proliferation of cloud computing, big data and analytics, smart sensors, and the Internet of Things has improved global connectivity. By 2020, the world will have more than 28.1 billion connected devices.[38] With increased global connectivity and ever improving technology, there is now far greater scope to include applied digital technologies in the manufacturing process.
- Changing consumer markets – The automotive sector is currently in the midst of landmark product innovations such as electric and autonomous cars which are changing consumer demands.[39] OEMs are increasingly recognising that 'smart' automotive factories enable manufacturers to deliver increasingly customised vehicles, personalisation and quicken the production process and thereby enable faster time-to market. This in turn makes them better able to meet changing consumer demands.
- Rising labour costs – According to Research and Markets, rising labour costs and wage inflation is driving demand for automotive robotics,[40] with manufacturers looking to find cheaper methods of production.

Barriers to growth and take-up

As outlined earlier, the lack of a "*deep, co-ordinated national strategy*"[41] is seen as a key barrier. KPMG's 2017 report also highlighted two further barriers. Firstly, digital skills are not sufficiently well spread within firms. The UK especially lacks people to fill digital support roles including digital scientists, digital engineers, and digital architects. Secondly, the report spoke about the potential risks of cyber-attacks, with several UK manufacturers having suffered attacks aimed at disrupting networked production equipment.[42]

Main market players

Figure 4.1 below lists some of the main global market players in this sector. These are provided to illustrate how industry leaders within automotive manufacturing are utilising digital technologies. They are not North East or UK-specific.

35 Urban Foresight (2018). Market research to inform the development of the North East Automotive Strategy – Manufacturing and Process Innovation. Research undertaken for the North East LEP; not published.
36 World Economic Forum (date unknown) Building a digital automotive industry. Internet, available at http://reports.weforum.org/digital-transformation/building-a-digital-automotive-industry/ (accessed 13 April 2018)
37 Roland Berger (date unknown) The Car Factory of Tomorrow is Digital. Internet, available at https://www.rolandberger.com/en/Blog/The-car-factory-of-tomorrow-is-digital.html (accessed 13 April 2018)
38 World Economic Forum and Accenture (2016) Digital Transformation of Industries: Automotive Industry. Internet, available at https://www.accenture.com/t20170411T120057Z__w__/us-en/_acnmedia/Accenture/Conversion-Assets/WEF/PDF/Accenture-Automotive-Industry.pdf (accessed 13 April 2018)
39 ARC Advisory Group (2017) Mercedes Moves to Smart Manufacturing. Internet, available at https://industrial-iot.com/2017/03/mercedes-moves-towards-industrie-4-0/ (accessed 13 April 2018)
40 Globe Newswire, 23 January 2018, Global Automotive Robotics Market 2017-2021
41 KPMG (2017) The Digitalisation of the UK Automotive Industry, p. 13
42 Ibid, p.22

Figure 4.1: Examples of the main market players in usage of applied digital technologies in automotive manufacturing

Firm	Main competitive advantages	Characteristics
Audi	Sensor-equipped manufacturing	Their tool-making division has design self-learning technology to help exert the right amount of pressure during stamping operations on press lines[43]
Siemens	Digitalisation of the shop-floor	Has introduced a Totally Integrated Automation (TIA) data platform. This has helped digitalise the shop floor by connecting virtual and real manufacturing. Notable highlights include their role in developing a new digital factory in Changzhou for BAIC, China's largest electric vehicle manufacturer[44]
Mercedes-Benz	Human Robot Collaboration	Working with KUKA AG, a systems integrator and robotics manufacturing company, Mercedes has developed robots that supports workers with physically demanding tasks such as placing items overhead.[45] This is part of Mercedes' development of 'Smart Operations' across its factories[46]
Cisco	Plant device management and development of manufacturing execution services (MES).	Cisco has provided the architecture to let manufacturers integrate real-time plant-floor data with supply chain management and other delivery systems. Previous projects have included helping Daimler Trucks North America introduce IoT at their plant[47]

Source: Technopolis analysis

Chemicals manufacturing

Global market size

There is no single analysis that estimates the size of the global market for applied digital technologies in this sector but many studies that identify the size of the market for specific technologies. These figures are for the chemicals industry as a whole (i.e. a broader range of activities than chemicals manufacturing).

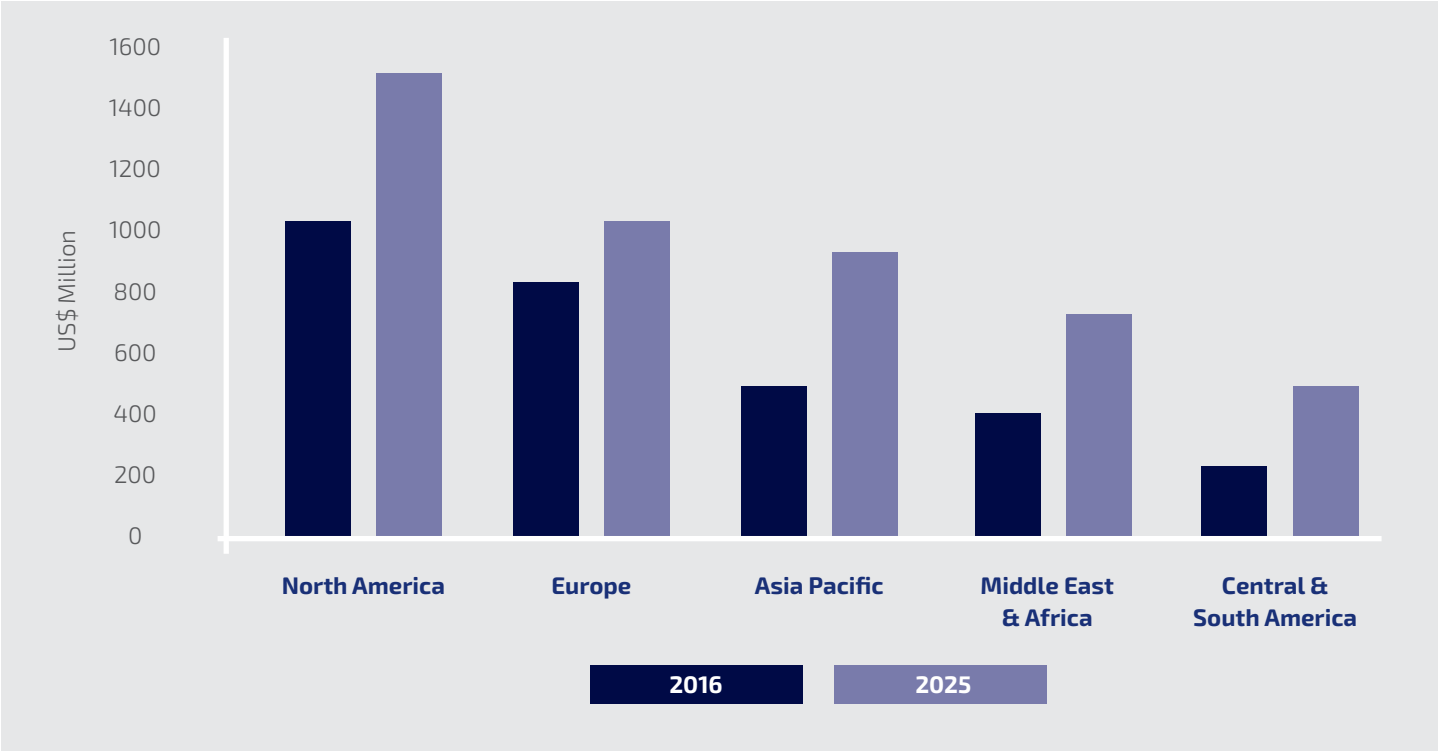
- Robotics – According to research by Technavio, the material handling robotics market, covering activity such as handling of hazardous materials, is expected to exceed $3.4 billion by 2019. It is expected to grow at a Compound Annual Growth Rate (CAGR) of approximately 9%.[48]
- Internet of Things – Analysis from GME suggests that the IoT chemicals market was worth approximately $3 billion in 2016, being forecast to rise to approximately $4.7 billion in 2025.[49] Additional research by Vertical Market research has indicated a CAGR of 16.1% for the global market for IoT in process manufacturing industries (including chemicals).[50]
- Chemical software – This is used in the chemicals industry for purposes including chemical mixing, inventory management, and uncertainty analysis. Estimates on the current size of the market are not publicly available but recent analysis by Research and Markets forecast the global chemical software market to grow at a CAGR of 11.4% between 2018 and 2022.[51]

43 Automotive World (18 July 2016) Industry 4.0 and the rise of smart manufacturing. Internet, available at https://www.automotiveworld.com/analysis/industry-4-0-rise-smart-manufacturing/ (accessed 13 April 2018)
44 Automotive Manufacturing Solutions (10 August 2017) Smart manufacturing for green mobility. Internet, available at https://automotivemanufacturingsolutions.com/from-the-industry/smart-manufacturing-green-mobility (accessed 13 April 2018)
45 Daimler (4 December 2012) Human-robot co-operation: Innovative Cooperation between Workers and Robots at Mercedes Benz. Internet, available at http://media.daimler.com/marsMediaSite/en/instance/ko/Human-robot-cooperation-Innovative-Cooperation-between-Workers-and-Robots-at-Mercedes-Benz.xhtml?oid=9917300 (accessed 13 April 2018)
46 Industrial IoT (22 March 2017) Mercedes Moves to Smart Manufacturing. Internet, available at https://industrial-iot.com/2017/03/mercedes-moves-towards-industrie-4-0/ (accessed 13 April 2018)
47 Cisco (date unknown) Cisco Automotive Solutions. Internet, available at https://www.cisco.com/c/en/us/solutions/industries/automotive.html (accessed 13 April 2018)
48 Modern Materials handling (30 March 2016) Global material handling robotics market to exceed $20 billion by 2019. Internet, available at https://www.mmh.com/article/global_material_handling_robotics_market_to_exceed_20_billion_by_2019
49 GME (7 January 2018) Internet of Things in Chemicals Market Size, Share, Analysis – Forecasts to 2025. Internet, available at https://www.globalmarketestimates.com/internet-things-chemicals-market/ (accessed 13 April 2018)
50 Cited in SAP (2014) CEO Perspective: The Internet of Things for Chemicals. Internet, available at http://www.iotsworldcongress.com/wp-content/uploads/2016/01/document.pdf (accessed 13 April 2018)
51 Research and Markets (2018) Global Chemical Software Market 2018-2022. Internet, available at https://www.researchandmarkets.com/research/d6vj4c/global_chemical?w=5 (accessed 13 April 2018)

The UK's position in the global market

There is little analysis on either the North East's or the UK's share of the global market in this sector. GME[52] found that in 2016, Europe accounted for approximately 28% of the global market in IoT for the chemicals industry. The size of the European market is expected to grow by around 25% between 2016 and 2025 – but given the faster growth in other markets, Europe's share of the global market is forecast to fall to 22% in 2025.

Figure 4.2: Size of the global market of Internet of Things Chemicals market (2016 and 2025)



Source: GME

Market drivers

The main drivers for the adoption of applied digital technologies in chemicals manufacturing include the following:

- Mitigating supply chain risks – Chemicals manufacturers are increasingly realising the contribution that IoT technologies can have in managing supply chain risks. They for instance can use predictive maintenance to detect possible malfunctions, track logistics for location and authenticity, and monitor changes in temperature and moisture. Companies like Dow have built supply chain risk management programmes to help improve their supply chains in these ways.[53]
- More efficient data management – For many chemicals companies, data tend to be stored on different systems: financial and marketing on one; operations, production and manufacturing on another; and R&D on another. Firms are seeing high performance computing and Industry 4.0 technologies as way of bringing all of these together and providing more meaningful insights to chemicals manufacturers.[54]
- Safety management – Safety remains a pressing concern within the industry given the toxic and dangerous nature of materials used and produced. Components can also be difficult to transport which constrains supply chain flexibility, and also requires more stringent security and process safety.[55] In other cases, plants may have to be shut down temporarily to make conditions safe enough for manual inspections. Consequently, some chemical manufacturers are turning to equipment such as unmanned drones fitted with high resolution cameras and a variety of sensors to facilitate safety checks and safety management.[56]
- Growing international competition in the sector – Europe's chemicals output has been shrinking considerably in recent years with production increasingly shifting to the Middle East, Far East, and Gulf regions. To combat this, there is growing attention in introducing measures that can help organisations add value to the manufacturing process, thereby helping them compete with other regions.[57]

52 GME (7 January 2018) Internet of Things in Chemicals Market Size, Share, Analysis – Forecasts to 2025. Internet, available at https://www.globalmarketestimates.com/internet-things-chemicals-market/ (accessed 13 April 2018)
53 EY (2016) Chemicals in Europe: the way forward – balancing the equation with customized innovation and strategy, p. 10. Internet, available at http://www.ey.com/Publication/vwLUAssets/EY-chemicals-in-europe-the-way-forward/$FILE/EY-chemicals-in-europe-the-way-forward.pdf (accessed 13 April 2018)
54 Deloitte (2016) Industry 4.0 and the chemicals industry: Catalysing transformation through operations improvement and business growth, p. 12. Internet, available at https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/Deloitte-Industry-4.0-and-the-chemicals-industry.pdf, (accessed 13 April 2018)
55 ARC Insights (2017) Industrie 4.0 in the Chemical Industry, p.3. Internet, available at https://www.osisoft.com/whitepapers/wp-Covestro-Industrie-4-0.pdf (accessed 13 April 2018)
56 Deloitte (2016) Industry 4.0 and the chemicals industry, p. 6
57 ARC Insights (2017) Industrie 4.0 in the Chemical Industry, p.3.

Barriers to growth and take-up

An important factor hindering the growth of the market is glitches in system integration and interoperability. For instance, certain types of software may not work with an organisation's legacy IT infrastructure, while other organisations may lack the capacity to adopt digitalisation. Technical glitches can also hamper business and manufacturing continuity (and in turn, create monetary losses), making some organisations wary of introducing new systems.[58]

Analysis by Accenture also found that very few major chemicals companies have meaningful plans about how and why they will roll out digital processes.[59] Part of this may be attributable to a lack of resources given growing international competition in the sector as alluded to above. In turn, this implies that applied digital technologies are not being used as extensively or optimally as they could be.

Accenture's research highlights a similar issue to that being faced in the automotive manufacturing and pharmaceutical manufacturing sectors. A shortage of digital skills amongst the workforce is preventing some 29% of chemicals companies from further using connected and intelligent products.[60]

Main market players

Figure 4.3 below lists some of the main global market players in this sector. These are provided to illustrate how industry leaders within chemicals manufacturing are utilising digital technologies. They are not North East or UK-specific.

Figure 4.3: Examples of the main market players in usage of applied digital technologies in chemicals manufacturing

Firm	Main competitive advantages	Characteristics
PURAGLOBE Germany GmbH	Roll-out out of Industry 4.0 in the chemicals industry ("Chemicals 4.0")	Considered as being a prominent best practice example of implementing "Chemicals 4.0" in a bespoke chemicals plant. Having established a plant in Saxony-Anhalt, it is now looking to set up identical plants elsewhere in the world. Data across all sites are analysed centrally to help create harmonised manufacturing processes and products[61]
Covestro	Implementation of Industry 4.0 in the chemical sector	The firm is closely involved in the use of data sharing and sensors to improve reliability and supply chain interaction. Approaches have been rolled out across 60 plants[62]
Dow	Internet of Things in chemicals manufacturing Integrated supply chains Cloud computing	Started an RFID, GPS, AutoID, and Telemetry Center in 2001. Was one of the first adopters of RFID (barcode tracking systems) and GPS to track materials and products. Also has used IoT to develop one of the most advanced supply chain risk management programmes in the world.[63] Several cloud computing solution companies have also been spun-out from Dow[64]
PAR Systems	Chemical robotics	One of the market leaders of robotics that can handle decomposing chemicals and are engaged in both remote and contact maintenance[65]
SAP	Internet of Things in chemicals manufacturing	Has a global chemical industry group which looks to develop software solutions for the sector. 6,500 chemical companies worldwide run SAP software and have worked with clients on areas such as the development of digital plants, and process analytics[66]

Source: Technopolis analysis

58 PR Newswire (22 March 2018) Global Chemical Software Market 2018-2022: Digital Transformation and the Automation of the Chemical Industry. Internet, available at https://www.prnewswire.com/news-releases/global-chemical-software-market-2018-2022-digital-transformation-and-automation-of-the-chemical-industry-300618339.html (accessed 13 April 2018)
59 Petrochemical Update (30 November 2017) Digital technology could boost value of chemical sector by $4.4 billion. Internet, available at http://analysis.petchem-update.com/workforce-development/digital-technology-could-boost-value-chemical-sector-44-billion (accessed 13 April 2018)
60 Ibid.
61 News Cision (11 July 2017) Chemcials 4.0: facing the future with success. Internet, available at http://news.cision.com/img---investment-and-marketing-corporation-saxony-anhalt/r/chemicals-4-0--facing-the-future-with-success,c2305280 (accessed 13 April 2018)
62 See for example ARC Insights (2017) Industrie 4.0 in the Chemical Industry, p.3.
63 Logistics Viewpoints (25 May 2015) Using IT as a Competitive Weapon: Dow Chemical, PepsiCo, and the Internet of Things. Internet, available at https://logisticsviewpoints.com/2015/05/25/using-it-as-a-competitive-weapon-dow-chemical-pepsico-and-the-internet-of-things-2/ (accessed 13 April 2018)
64 Guertzgen, S. (21 July 2017) Innovation in the Chemical Industry. Internet, available at https://blogs.sap.com/2017/07/21/innovation-in-the-chemical-industry/ (accessed 13 April 2018)
65 Robotics Online (18 January 2017) Chemical and Hazardous Material Handling Robotics. Internet, available at https://www.robotics.org/content-detail.cfm/Industrial-Robotics-Industry-Insights/Chemical-and-Hazardous-Material-Handling-Robotics/content_id/614 (accessed 13 April 2018)
66 SAP (date unknown) Chemicals Industry webpage. Internet, available at https://www.sap.com/uk/industries/chemicals.html (accessed 13 April 2018)

Pharmaceutical manufacturing

Global market size

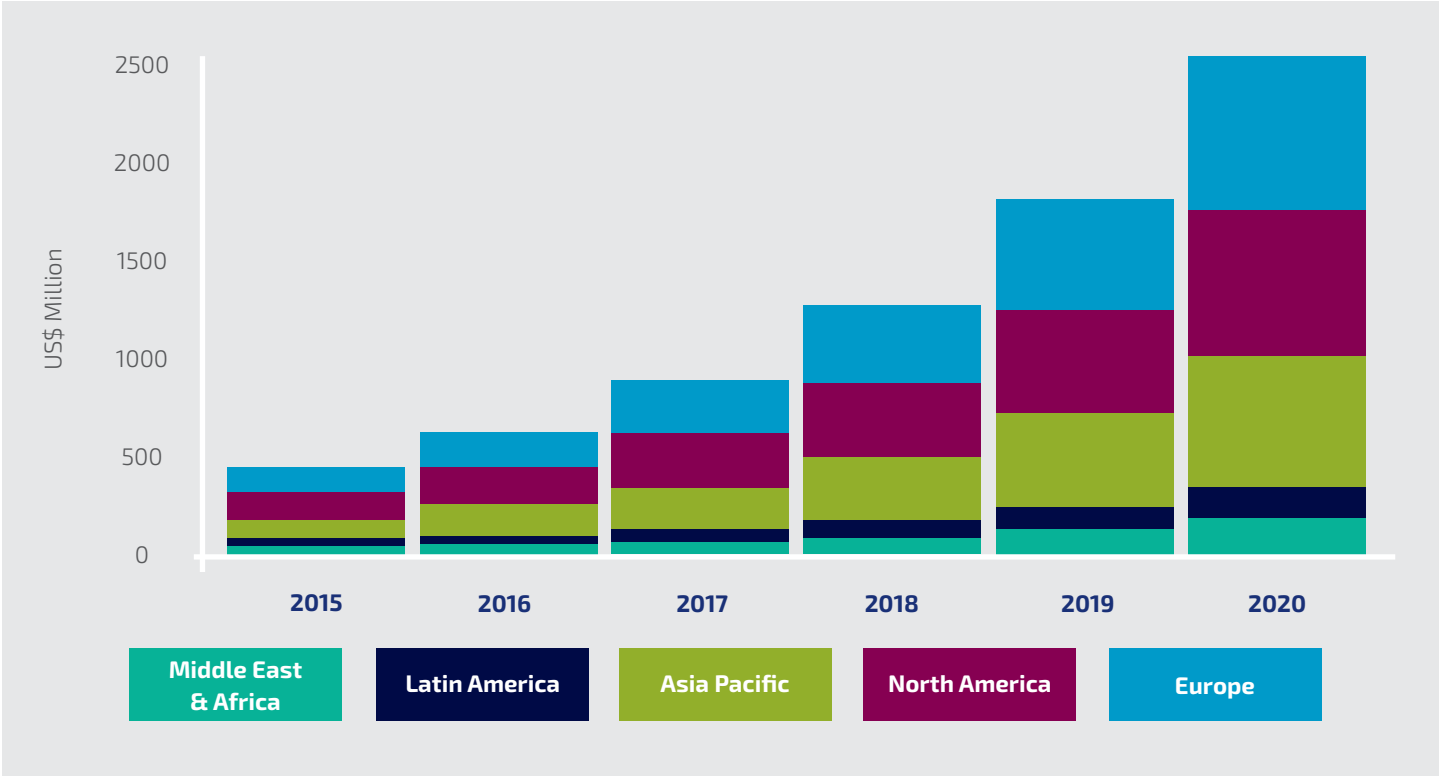
There is no single piece of analysis that estimates the market size of the applied digital technologies market in pharmaceutical manufacturing. As shown below, some commentators have provided market value for some of the most important sub-markets of applied digital technologies, but these apply to the pharmaceutical industry as a whole and not just pharmaceutical manufacturing.

- Internet of Things (IoT) – According to Global Data, the market for IoT software and services in the pharmaceutical industry was valued at $420 million in 2015. It is expected to be worth $2,486 million by 2020, growing at a Compound Annual Growth Rate (CAGR) of 42.7% from 2016 to 2020.[67]
- Robotics – According to Grand View Research, the global pharmaceutical robots market size was valued at $130 million in 2016[68] and is expected to reach $430 million by 2025.[69]
- Data analytics – The global commercial pharmaceutical data analytics market was valued at $1.3 billion in 2016 and is forecast to grow at a CAGR of 15.0% during the period 2016 to 2021.[70]

The UK's position in the global market

There is little analysis about either the North East, or the UK's share of any of the global applied digital technology markets for pharmaceutical manufacturing. Global Data[71] has produced analysis looking at Europe's share of the global IoT software and services for pharmaceuticals. As shown below, Europe's global market share is expected to remain consistent at approximately 31% between 2015 and 2020. The overall size of the European market will however, increase by 514% over the same period.

Figure 4.4: Global market by region for IoT software and services in pharmaceuticals



Source: Global Data

67 GlobalData (20 March 2018) IoT software and services in the pharmaceutical sector will be wroth $2.4 billion by 2020, says GlobalData. Internet, available at https://www.globaldata.com/iot-software-services-pharmaceutical-sector-will-worth-2-4-billion-2020-says-globaldata/ (accessed 13 April 2018)
68 Grand View Research (2017) Pharmaceutical Robots Market Size Share Industry Report. Internet, available at https://www.grandviewresearch.com/industry-analysis/pharmaceutical-robots-market (accessed 13 April 2018)
69 Grand View Research (2017) Pharmaceutical Robots Market Size Worth $430.0 million by 2025. Internet, available at https://www.grandviewresearch.com/press-release/global-pharmaceutical-robots-market (accessed 13 April 2018)
70 PRNewsWire (10 October 2016) Commercial Pharmaceutical Analytics Market to Provide Over USD 1.5 Billion Revenue Post 2016. Internet, available at https://www.prnewswire.com/news-releases/commercial-pharmaceutical-analytics-market-to-provide-over-usd-15-billion-revenue-post-2016-300341921.html (accessed 13 April 2018)
71 GlobalData (20 March 2018) IoT software and services in the pharmaceutical sector will be wroth $2.4 billion by 2020, says GlobalData. Internet, available at https://www.globaldata.com/iot-software-services-pharmaceutical-sector-will-worth-2-4-billion-2020-says-globaldata/ (accessed 13 April 2018)

Market drivers

Research[72] into the North East pharmaceutical manufacturing sector identified a number of capabilities that North East businesses in this sector were developing or looking to develop. These included developing:

- Ultra-high potency manufacturing facilities.
- Continuous manufacturing facilities.
- Smart pharmaceutical packing – including intelligent and smart packaging for medicines and medical devices, physical, chemical and biological sensing capabilities and novel formulations and the delivery of medicines.

Digital technologies (e.g. sensors) and data analysis underpin all of these.

Commentators have pointed to several different factors which have encouraged greater use of applied digital technologies with pharmaceutical manufacturing in recent years:

- Tackling counterfeiting – Estimates suggest that within some developing countries counterfeit drugs comprise between 10% and 30% of the total medicines on sale.[73] Pharmaceutical manufacturers are constantly looking for systems that can stop counterfeit drugs and ingredients from contaminating supply chains and the incorporation of blockchains technologies is increasingly being seen as a route to this.[74]
- Product traceability – Pharmaceutical manufacturers rely heavily on product monitoring and traceability, including the ability to record incoming ingredients and raw materials, manufacturing processes, and equipment condition. Increased outsourcing of processes (due primarily to cost pressures) has led to increasingly complex supply chains and consequently, has necessitated the collection of greater product monitoring data.[75] As more and more data are being collected, often across different platforms, manufacturers are looking for systems that can bring all of these datasets together to enable better product traceability.[76]
- Rise of individualised medicines – Within the pharmaceutical market, there is growing attention on developing personalised medicine for smaller patient groups, believing these provide much more effective treatment than a one-drug-fits-all approach. Manufacturing individualised drugs on a smaller scale however, creates additional concerns about process robustness and the stability of batches. The use of intelligent machines, the IoT, and data analytics is seen as an efficient and effective way of doing this.[77]
- Increased regulation – Previously, regulators might only have asked for an annual product quality review but increasingly, they are demanding continuing product monitoring. This is driving increased use of data analytics to provide continuous, real-time monitoring of manufacturing processes, and to help show and predict any deviations from defined parameters.[78]
- Recognition of efficiency gains – Pharmaceutical plants typically experience high levels of downtime[79] with paperwork and results having to be checked and cross-referenced. Manufacturers have realised the use of digitisation and analytics can reduce this downtime by 30-40%[80] and some are looking to digitalisation and paperless manufacturing to enable continuous drug production.[81]

Barriers to growth and take-up

As with the automotive industry, a lack of skills is an issue to take-up. Commentators have spoken of a need for more bespoke data scientists – individuals who can understand digital technologies and the software siting behind them, but also be able to interpret the data and how to amend production processes accordingly.[82] Cybersecurity is also a barrier with concerns about being able to protect commercially and scientifically sensitive information.[83]

Other barriers to take-up are more specific to the pharmaceutical manufacturing sector. For instance, the pharmaceutical industry has often been characterised as being risk averse and conservative. Consequently, it has tended to be slow adopter of new technologies and processes.[84] Regulation is also a concern within the pharmaceutical industry. As a highly regulated industry, it can be difficult to adopt new technologies without having to get entire production processes re-validated.[85] Both aspects have the potential to slow the uptake of applied digital technologies in this sector.

72 North East LEP, First for Pharma and CPI (2017) Profile and Importance of the North East Pharmaceutical Manufacturing Sector: Growing its Contribution.
73 Medical Futurist (date unknown) What the Hell is Blockchain And What Does it Mean for Healthcare And Pharma? Internet, available at http://medicalfuturist.com/what-the-hell-is-blockchain-what-does-it-mean-for-healthcare-and-pharma/ (accessed 13 April 2018)
74 Ibid.
75 Veeva (date unknown) Pharma 4.0 – time to rethink manufacturing and quality. Internet, available at https://www.veeva.com/eu/wp-content/uploads/2016/01/Manufacturing-Chemist-Pharma-4.0-1.pdf (accessed 13 April 2018)
76 Pharmaceutical Manufacturing (2016) Creating Value from Smart Manufacturing. Internet, available at https://www.pharmamanufacturing.com/articles/2016/creating-value-from-smart-manufacturing/?start=1 (accessed 13 April 2018)
77 Veeva (date unknown) Pharma 4.0 – time to rethink manufacturing and quality
78 PharmOut (date unknown) Pharma 4.0 – How Industry 4.0 Impacts in Pharma. Internet, available at https://www.pharmout.net/pharma-4-0/ (accessed 13 April 2018)
79 Ehrhardt, M. and Behner, P. (19 October 2016) Digitization in pharma: Gaining an edge in operations. Internet, available at https://www.strategyand.pwc.com/reports/digitization-in-pharma (accessed 13 April 2018)
80 Ibid.
81 Markarian, J. (2016) The Internet of Things for Pharmaceutical Manufacturing. Internet, available at http://www.pharmtech.com/internet-things-pharmaceutical-manufacturing?pageID=2 (accessed 13 April 2018)
82 PharmOut (date unknown) Pharma 4.0 – How Industry 4.0 Impacts in Pharma
83 Ehrhardt, M. and Behner, P. (19 October 2016) Digitization in pharma: Gaining an edge in operations
84 Fisher, E. (30 May 2012) Mobile revolution: how have drug developers embraced smart device technology? Internet, available at https://www.pharmaceutical-technology.com/features/featuremobile-revolution-drug-developers-smart-device-technology/ (accessed 13 April 2018)
85 Pharmaceutical Manufacturing (2016) Creating Value from Smart Manufacturing

Main market players

Figure 4.5 below lists some of the main global market players in this sector. These are provided to illustrate how industry leaders within pharmaceutical manufacturing are utilising digital technologies. They are not North East or UK-specific.

Figure 4.5: Examples of the main market players in usage of applied digital technologies in pharmaceutical manufacturing

Firm	Main competitive advantages	Characteristics
Johnson & Johnson	Continuous manufacturing / Industry 4.0	Their Janssen drug unit worked on a continuous manufacturing process for five years and won approval from US Food and Drug Administration (FDA) to switch from batch to continuous manufacturing for the HIV drug Prezista[86]
Novartis	Continuous manufacturing / Industry 4.0	Entered a 10-year research collaboration programme with the Massachusetts Institute of Technology (MIT) in 2007 to develop new continuous flow manufacturing technologies[87]
Eli Lilly	Continuous manufacturing / Industry 4.0	Their Ireland site achieved an industry-first continuous process to make a compound for Phase I and II clinical trials[88]
Pfizer	Continuous manufacturing / Industry 4.0	In May 2017, Pfizer opened a 'modern, tablet production, continuous manufacturing plant' in Freiburg, Germany[89]
Caywon	Supply chain integration	The first international pharmaceutical company to adopt Crowd Machine, a data analytics and blockchain process that helps bridge communication gaps between different pharmaceuticals experts and technologies in the supply chain[90]

86 Cited in Tefen (date unknown) The Impact of Industry 4.0 on the Pharma Industry. Internet, available at https://www.tefen.com/insights/industries/Patient_Care/the_impact_of_industry_40_on_the_pharma_industry (accessed 13 April 2018)
87 Ibid.
88 Ibid.
89 Ibid.
90 Ibid.

5. Local science and innovation assets

Key messages

The North East is home to a wide range of national, regional and local assets that support one or more of the industries covered by the SIA. These include facilities, applied research organisations, networks, skills providers and specialised funding sources.

A particular strength is the Innovation SuperNetwork which works to encourage collaborations across networks and sectors.

A main gap in the asset base is support for the integration of digital solutions into businesses, with a lack of facilities for test and demonstration prior to full deployment in the manufacturing processes and supporting the adoption of new technologies.

Despite good examples of networks that bring business and research activities together (such as Northern Accelerator) there is potential to deepen these activities particularly in relation to applying digital technologies to advanced manufacturing.

Introduction

As we saw in the earlier chapters, the North East is home to a wide range of businesses in the SIA industries, alongside research expertise in the universities and elsewhere. This section will outline the broader assets that support these industries such as networks, finance and facilities. These assets, alongside cross-sector networks and connectivity within a relatively close-knit region, represent a particular, if underutilised, strength in supporting innovation to occur. There is clear potential to utilise the ongoing relationships, trust and formal and informal networking opportunities to stimulate innovation and develop new solutions.

Figure 5.1 sets out the key assets that support each industry, alongside those assets that support multiple industries or form part of the wider ecosystem. More details on key assets is provided in Appendix 4. In addition to these individual assets, both North East LEP and the Tees Valley Combined Authority have Innovation Boards that drive collaborative innovation.

In comparison to other parts of the UK, the North East is home to a concentration of related assets. In particular, it is one of five locations for the High Value Manufacturing Catapult and one of three with a dedicated centre within the Digital Catapult. The North East is not unique in being home to Catapult Centres or other research capacity however the strong network linkages across sectors and a willingness to take forward joint working between Catapult Centres and other regional and local organisations provides additional scope for activity. The Innovation SuperNetwork is an unique approach to providing the structure and framework for enabling these links to be made across the region.

Figure 5.1: Key science and innovation assets in North East

	Automotive manufacturing	Chemicals manufacturing	Pharmaceutical manufacturing	Digital	Wider ecosystem/ supports multiple sectors
Facilities	• A19 Enterprise Zone and IAMP • Zero Carbon Future • Automotive and Manufacturing Advanced Practice Centre (AMAP), University of Sunderland	• Materials Processing Institute (MPI) • TWI • Technology Futures Institute	• Newcastle Laboratory	• Sunderland Software City • VRTGO Labs/Proto Lab • BOHO • Cobalt Data Centre • Digital Quarter • Immersion Labs, Gateshead • Sunderland Fab Lab	• NETPark • Newcastle Helix • Advanced Manufacturing Science Park • Northern Design Centre
Applied research		• Materials Processing Institute • TWI • Technology Futures Institute • CPI – Graphene Application Centre	• CPI - National Biologics Manufacturing Centre • CPI – National Formulation Centre	• Advanced Research Computing, Durham University • National Innovation Centre for Data • Northumbria University BIM Academy • University of Sunderland – Faculty of Computer Science • Urban Observatory	• CPI –National Printable Electronics Centre (with additional potential new Centre for Smart Packaging proposed)
Networks	• North East Automotive Alliance • Zero Carbon Future • Hydrogen Partnership	• North East Process Industry Cluster • Materials Processing Institute • TWI • Technology Futures Institute	• First for Pharma • North East Process Industry Cluster	• Sunderland Software City • Digital City • Digital Union • Dynamo • VRTGO Labs/Proto Lab • BOHO • Thinking Digital	• Innovation SuperNetwork • Design Network North
Skills	• Centre of Excellence in Sustainable Advanced Manufacturing (CESAM) (forthcoming) • Gateshead College – SASMI • Nissan Academy • Hitachi UTC			• Dynamo Apprenticeship Programme	• Ignite Centre for Engineering & Innovation, Tynemet College
Finance				• Ignite Accelerator Programme	• North East Fund • Northern Powerhouse Investment Fund
Other			• National Innovation Centre for Ageing • Centre for Ageing and Vitality • Centre for Life • Academic Health Science Network North East and North Cumbria	• Digital Catapult North East and Tees Valley • Satellite Applications Catapult • HM Revenue and Customs Digital Delivery Centre • NHS Business Services Authority • Stellium • North of Tyne Devolution Deals	• North East Growth Hub • Tees Valley Growth Hub/Business Compass • High Value Manufacturing Catapult • Northern Accelerator • Voice North

Source: Compiled by SIA consortium members
Notes: 1.Assets may appear in multiple cells (e.g. facilities and network).
2. In relation to pharmaceutical manufacturing, a number of wider assets in life sciences have been included (e.g. Academic Health Science Network North East and North Cumbria an Centre for Life) reflecting the recognition that an important strength of the North East pharmaceutical manufacturing sector is that it forms a part of the wider ecosystem, with the North East being one of the few locations that can provide an end-to-end translation environment ('bench to bedside').

Automotive manufacturing

The automotive manufacturing sector is a significant aspect of the North East economy with a wide range of businesses and wider assets.[91] As identified in the evidence base for the developing automotive sector strategy, the North East is home to a number of large, international vehicle manufacturers including Hitachi, Nissan, Komatsu and Caterpillar. The businesses are supported by an extensive supply chain and more niche manufacturers such as Hyperdrive International (who are developing new battery technologies). Within this, the SIA has focused on automotive – but recognises that there are synergies and overlaps with other vehicle types.

The large estate related to the automotive manufacturing is located throughout the North East and there is good access to physical premises. This is being expanded and enhanced with increased availability of land through the Enterprise Zone sites including the manufacturing-focused sites on the A19, International Advanced Manufacturing Park (IAMP) in Sunderland and South Tyneside and sites across Tees Valley, Durham and Gateshead.[92] These sites accompany wider transport manufacturing sites around Durham and Chester-le-Street areas. These sites are linked to each other and outward facing infrastructure by the dual-carriageway and motorway network.

The physical assets around this strong and growing business base are supported by research excellence and strong networks. The North East Automotive Alliance (NEAA) is a highly successful sector-led organisation which aims to support the automotive sector in the North East to grow. With over 140 businesses and organisations involved, NEAA is the largest automotive network in the UK.[93] By bringing together this range of partners, NEAA can work with other sectors and organisations to develop solutions for the North East's automotive manufacturing sector.

Increasing the interaction between manufacturers and research institutions in the North East is an important priority, drawing on the research excellence in the five local universities and Catapults in the North East. The forthcoming Centre of Excellence in Sustainable Advanced Manufacturing (CESAM) and established High Value Manufacturing Catapult centre are important assets here strengthening the opportunities for applied research and the incorporation of this into manufacturing techniques and processes.

Chemical manufacturing

Within the North East, the chemical manufacturing sector is located primarily in the Tees Valley with a separate SIA being undertaken specifically on this sector setting out in more detail the assets, opportunities and challenges faced. The region is home to clusters in the chemical sector including refining, petrochemicals, speciality and fine chemicals, plastics and biotechnology. The sector is dominated by international corporations, with the majority of these businesses having both manufacturing sites and either headquarters function or research development and innovation facilities in the region. Key businesses include Chemoxy, Johnson Matthey, Huntsman, Lotte Chemical, Lucite International, SABIC Petrochemicals, Tracerco, Conoco Philips and Procter and Gamble. All of these businesses have highly integrated supply chains in close co-location.

As one of the three chemicals clusters across the Northern Powerhouse region, the sector continues to benefit from tight supply chains, coastal access and the co-location of affordable feedstocks. However, challenges have been identified around costs and competition which have resulted in the UK becoming a less important player within the global market. Better use of their existing estates means that there is significant opportunity for inward investment within each cluster and alongside increased digitisation and the opportunities created by the circular economy this provides scope for increased reshoring.[94] The attractiveness of co-location, particularly from a foreign direct investment perspective, has been strengthened through investment in aspects of industrial symbiosis, in particular the use of district heating schemes, hydrogen and the use of carbon capture and storage, which cumulatively impact on the cost efficiency of each of these locations.

The region also benefits from having access not only to the Northern 8 (N8) group of universities but also to a suite of specialist innovation support, delivered by locally based national innovation centres, such as Centre for Process Innovation (CPI), MPI and TWI. The sector as a whole invests heavily in research and development, but the Tees Valley, alongside other Northern Powerhouse regions, is a key location for manufacture. As a result, the ecosystem is more heavily orientated towards investment in innovation, helping enhance the productivity of this nationally important enabling sector. These links are already demonstrating business benefits with the likes of the Teesside University and Orema activities developing smart helmet technology to support process industries.[95]

91 Urban Foresight (2018) Title to be added
92 https://investnortheastengland.co.uk/development-opportunities/
93 https://www.northeastautomotivealliance.com/about-neaa/
94 Tees Valley Combined Authority and Durham University (2018) Chemicals and process science Science and Innovation Audit.
95 https://www.tees.ac.uk/sections/news/pressreleases_story.cfm?story_id=6786&this_issue_title=March%202018&this_issue=298

Pharmaceutical manufacturing

The North East is home to 15 pharmaceutical manufacturing organisations including both large multinationals such as GlaxoSmithKline, Merck, Sharp and Dohme Limited (MSD), and FUJIFILM Diosynth and smaller, more specialised businesses such as Biosignatures, Glythera and Orla Proteins. Brought together in an active network by First for Pharma, a recent study undertaken by the partnership highlights the main assets and opportunities.[96] The region hosts a mix of Contract Development and Manufacturing Organisations (CDMOs), large multi-national drug developers and smaller supply chain companies. The region's long-term strength in this sector continues to attract manufacturers and investors with a number of major investments over recent years (for example, Piramal Healthcare and Sterling Pharma Solutions). Particular innovation strengths include the implementation of continuous pharmaceutical manufacturing by MSD, Aesica and Arcinova. Aesica is also active in high potency manufacture.

The pharmaceutical manufacturing sector sits within a broader regional strength around health and life sciences, with the North East home to (amongst others) the Centre for Ageing and Vitality, the Centre for Life and the new National Innovation Centre for Ageing based on Newcastle Helix. The importance of these connections and the North East's unique end-to-end translation environment ('bench to bedside') have been recognised nationally.

"The North East has a diverse and vibrant clustering of life sciences, manufacturing and health services. I believe that the work that is being done in the North East can support more growth in the region and make a strong contribution to a wider UK initiative to promote research collaboration, partnership and investment globally as part of the Government's Life Sciences Industrial Strategy"

Sir John Bell GBE, FRS, FMedSci
Regius Professor of Medicine, University of Oxford
Chairman, Office for the Strategic Coordination of Health Research
Sponsor of the Life Sciences Industrial Strategy

The development of a laboratory space with easy access for SMEs on the Newcastle Laboratory site will complement the existing development at NETPark in County Durham and the CPI sites in County Durham and Darlington. Combined, these provide a range of spaces to start and grow businesses as well as the specific facilities (including CPI's Centres for Healthcare Photonics, Formulation, Biologics and Printable Electronics). These support the development of new technologies and approaches within pharmaceutical manufacturing.

Other sources of competitive advantage for the region are its strong international connectivity (with five ports and two airports) plus the natural environment. In particular, the low levels of air pollution in more rural areas is beneficial to pharmaceutical manufacture and other areas which are sensitive to pollution levels.

96 First for Pharma, CPI and North East LEP (2017) Profile and Importance of the North East Pharmaceutical Manufacturing Sector: Growing Its Contribution..

Digital

The digital sector and specifically the areas around data collection, analysis and application has been identified as significant area for growth in the North East.[97] The North East is home to a number of large, global businesses with a focus on the digital and data sectors including Sage with its headquarters in Great Park Newcastle alongside large-scale activities at HP and Accenture. The presence of a large number of SMEs contributes to the North East's vibrant and diverse digital and data community.

These businesses benefit from a well-established and developing support system. Premises are available across the North East, ranging from start-up and co-working locations, such as BOHO in Middlesbrough, to Grade A offices in prime locations targeted at large corporate demand. This is accompanied by more specialist locations such as Proto in Gateshead which is targeted at augmented and virtual reality businesses providing a more niche level of support and networking opportunities.

The North East has attracted significant investment in national research assets in the digital sphere including the £30 million National Innovation Centre for Data[98] on the Newcastle Helix site which works with partners from across the private, public and academic sectors. This centre builds on existing strengths in the North East such as the Sunderland Software City, Digital City in Middlesbrough and the applied centres based at the North East universities such as the Institute of Advanced Research Computing at Durham University.

Other assets supporting the development of the digital and data sector in the North East include networks such as Digital Union, Dynamo and Sunderland Software City. The networks proactively seek to link businesses with new opportunities and more fully engage with each other and, working with publicly and privately funded business support, provide an encompassing support network for digital businesses. In particular, Sunderland Software City has been developing approaches for linking digital and non-digital businesses to achieve growth.

Other assets in the North East include:

- Stellium is one of the largest datacentres in the UK and provides interconnect facilities to all major carrier networks in the UK and a local fibre network that connects major sites across the region.
- The Urban Observatory holds more urban data than any other organisation in the UK, with over 650 million records. Sensor feeds across the Tyne and Wear area collect real-time data across 51 different categories.
- Benton Park View in Newcastle is home to the HMRC Digital Delivery Centre Headquarters.
- The North of Tyne Devolution Deal includes commitments to pioneer a smart data environment to improve local public services.

Wider ecosystem strengths

In addition to the assets specific to digital and individual advanced manufacturing sectors, the wider innovation ecosystem also provides a range of assets. Activities such as the North East and Tees Valley Growth Hubs, the Innovation SuperNetwork and the Northern Accelerator help businesses to develop and grow. The Innovation SuperNetwork works to enhance open innovation and to encourage collaboration across networks and sectors to stimulate new solutions and collaborations.

Innovation in the region benefits from a supportive approach to finance coordinated through the dedicated £120m North East Fund and the wider Northern Powerhouse Investment Fund. These help address the long-standing lack of availability of venture and equity capital in the region and build on the highly successful North East JEREMIE funds undertaken as part of the 2013-17 ERDF programme. The region also has a number of multi-purpose sites such as NETPark that host assets and provide facilities for businesses.

97 Urban Foresight (2016) Data for Growth.
98 https://www.ncl.ac.uk/press/articles/archive/2017/09/newnationalinnovationcenter/

6. Local science and innovation talent

Key messages

Over a third of those in the North East active in the labour market have a high level qualification (degree level or above), with a further 19% having an intermediate level qualification. The proportion with high level qualifications has increased over the last five years – suggesting a growth in the available skills base.

There are almost 50,000 individuals employed in science, research, engineering and technology professional roles in the North East. The numbers employed in this occupational group have increased by almost a third in the last five years.

There is increasing demand for higher level (degree-level and above) skills within both the advanced manufacturing and digital sector.

The North East's five universities offer a range of courses at both undergraduate and postgraduate level that align with the needs of the SIA industries, with large numbers of enrolments in computer science and engineering and technology. The majority of UK-domiciled students stay in the North East after graduation.

Introduction

This section sets out an overview of the people and talent available in the North East in relation to applied digital technologies in advanced manufacturing. The composition of the current workforce is examined, alongside projections about how skills needs are anticipated to change over time. The numbers currently studying subjects aligned to the SIA at university are also examined.

Current workforce

Within the North East's population of 2.6 million, there is a working age (16-64) population of 1.6 million.[99] In 2017, there were over 1.2 million residents active in the labour market (known as the 'economically active).[100] Looking at the qualifications of the economically active population in the North East.[101]

- 36.6% of economically active 16-64 year olds have a high level qualification (Level 4 or above[102]) and a further 19.0% have an intermediate level qualification (Level 3[103]).
- The proportion with high level qualifications has grown significantly over the last five years, from 31.0% to 36.6%.
- This, in part, reflects the inflow of younger workers who tend to be more highly qualified than older groups. 41.0% of 25-29 year olds and 43.6% of 30-39 year olds having a higher level qualification.

Data on qualifications by subject level is not available at the regional level. However, data on the numbers employed by occupation can give insights into the skills profile of the North East. In 2017, there were 49,800 individuals employed in science, research, engineering and technology professional roles in the North East – equivalent to 4.3% of all in employment in the region.[104] This category includes roles such as chemical scientists, biological scientists and biochemists, mechanical engineers, electrical engineers, programmers and software developers and R&D managers. A further 21,100 (1.8%) were employed in science, engineering and technology associate professionals (such as laboratory technicians, engineering technicians, quality assurance technicians, IT operations technicians, etc.).

4.3% of employment in the North East is in science, research, engineering and technology professional roles

Science

Research

Engineering

Technology

Looking at the those employed in science, research, engineering and technology roles in more detail:

- The proportion of employment in in science, research, engineering and technology professional roles is lower in the North East (4.3%) than across the UK as a whole (5.4%).
- The proportion of employment in in science, engineering and technology associate professional roles is similar in the North East (1.8%) as in the UK (1.9%).
- The numbers employed in science, research, engineering and technology professional roles in the North East has increased by 11,800 (31%) in the last five years (from 2012 to 2017). This is a much larger increase than across the UK (16%).

99 Population estimates – local authority based by single year of age (Nomis). Data for 2016.
100 Annual Population Survey (Nomis). Data for 2017.
101 Annual Population Survey (Nomis). Data for 2017.
102 Includes HND, Degree and Higher Degree level qualifications or equivalent.
103 Includes 2 or more A levels, advanced GNVQ, NVQ 3, 2 or more higher or advanced higher national qualifications (Scotland) or equivalent.
104 Annual Population Survey – Workplace Analysis (Nomis). Data for 2017.

Future skills needs

Forecasts published by the UK Commission for Employment and Skills (UKCES) in 2016 projected that employment in manufacturing in the North East would decline between 2014 and 2024 by 16,200 or by 1.6% per annum.[105] Over the same time period, there will be the need to replace 35,300 workers that have left manufacturing (due to retirement, moving into other sectors, etc.). Combined this means there will be a requirement for 19,200 new staff. Looking at the profile of these:

- The majority of these are in highly skilled roles, with the need for 2,800 managers, directors and senior officials, 3,300 professionals and 3,100 in associate professional and technical roles.
- In terms of qualifications, the greatest demand will be for those with undergraduate degree level qualifications (with 10,800 required at QCF Levels 4-6) and postgraduate degree level qualifications (with 2,200 required at QCF Levels 7-8). In contrast the need for those with no qualifications will decrease by 2,200.

Whilst forecasts are available for more detailed industries, the small numbers involved means care must be taken in interpreting these (i.e. they should be considered indicators of broad trends rather than too much weight being placed on the specific numbers forecast). The closest proxy available to digital is 'computing services'. The forecasts indicate that:

- Employment will grow in this sector in the North East between 2014 and 2024 (by 2,600). Combined with projected replacement demand of 4,000, there will be a need for 6,600 new staff.
- The majority of those required will be in professional roles (2,300) or associate professional and technical roles (1,300).
- Linked to this, the main area of demand will be for those with degree-level or above qualifications.

More generally, a wide range of literature[106] has suggested there will be increasing demand for digital skills in all sectors. The surveys of advanced manufacturing and digital businesses in the North East undertaken as part of this SIA found that:

- The majority of digital businesses surveyed planned to grow the numbers they employed over the next two years with three-quarters of them identifying recruiting staff with the skills and experience they need as being very important to their business over this time period.
- Around a third of the advanced manufacturing businesses that completed the survey reported that a lack of digital skills and capabilities within the business was acting as a barrier to adopting digital technologies at their North East sites. Around a third had experienced difficulties in recruiting individuals for digital-specific roles over the last 12 months due to a lack of available individuals with the skills and experience required. Around a fifth had experienced skills shortage vacancies over the same time period in relation to roles that involve the day-to-day use of digital technologies. Reflecting this, there was strong interest in interventions to increase the availability of digital skills (for example through more college and university courses) and in help for them to access training to improve the skills of their existing staff.

Developing skills for the future

As outlined above, there is increasing demand for degree-level and above qualifications in both the advanced manufacturing and digital sectors. In 2016/17, there were 101,615 students enrolled at the North East's five universities (Durham, Newcastle, Northumbria, Sunderland and Teesside).

Computer science	Engineering & technology	Biological sciences	Chemistry
5,340 enrolments	**9,765** enrolments	**9,365** enrolments	**1,575** enrolments

There were over 5,300 enrolments in computer science.

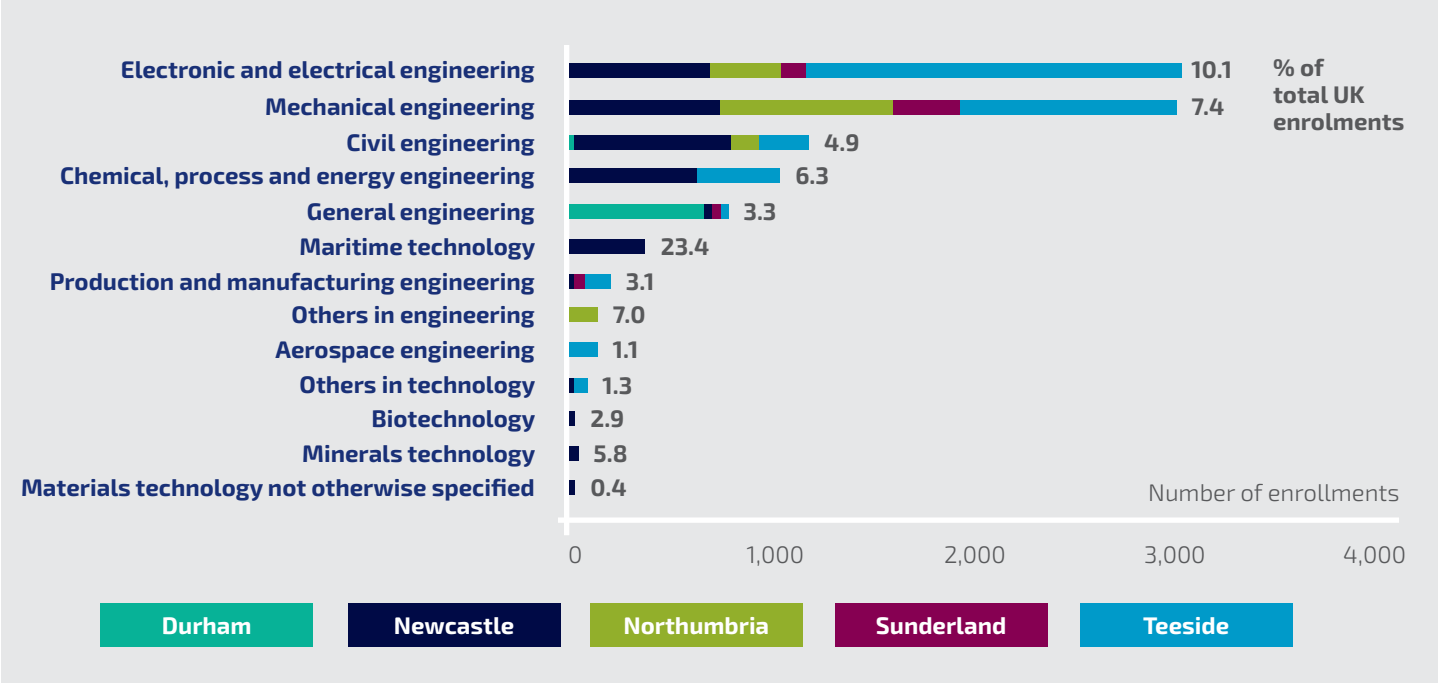
- This is 5.3% of all computer science enrolments across the UK. Given the North East accounts for just 4.0% of the UK population and North East universities account for 4.4% of student enrolments, this suggests that the North East's universities are overrepresented within computer science enrolments.
- All five universities provide courses in computer science, with Teesside University accounting for the largest number of enrolments with 1,915 enrolments. Northumbria University had 1,580 enrolments and Newcastle a further 1,030.

105 UKCES (2016) Working Futures 2014-2024.
106 For example, Bacon, L. and MacKinnon, L. (2016, with minor revisions 2017) Lifelong digital skills development, current picture and future challenges, Government Office for Science Foresight; ECORYS UK (2016) Digital skills for the UK economy, Department for Business, Innovation and Skills and Department for Culture Media and Sport; PWC (2018) Workforce of the Future: The Competing Forces Shaping 2030 ; Tech Nation (2018) Tech Nation 2018 Report.

With almost 9,800 enrolments, engineering and technology is the second largest STEM subject area in the North East universities. This covers a range of subjects that are relevant to both digital and advanced manufacturing.

- Again, the North East's universities are overrepresented in enrolments, with 5.9% of engineering and technology enrolments across the UK in the region.
- The universities with the largest enrolments in this subject area are Teesside (3,880), Newcastle (3,235) and Northumbria (1,450).
- Within the broad topic of engineering and technology, the subjects with the largest numbers of enrolments are electronics and electrical engineering (2,955) and mechanical engineering (2,935). The North East's universities have 10.1% and 7.4% of all enrolments in these subject areas. Both of these are highly relevant to advanced manufacturing and electronics and electrical engineering is also relevant to digital.
- Other engineering and technology subjects where the North East's universities are overrepresented within enrolments are chemical, process and energy engineering, maritime technology and minerals technology. These are a good match to the needs of the advanced manufacturing sectors in the region.

Figure 6.1: Student enrolments in engineering and technology, North East universities, 2016/17



Source: HESA Students 2016/17

Other subjects that are relevant to the SIAs include biological sciences and (within the broad category of physical sciences), chemistry. There were 9,365 enrolments in biological sciences and a further 1,575 in chemistry. The North East's universities are overrepresented in chemistry (6.4%) but slightly underrepresented in biological sciences (4.1%).

41% of all students enrolled at the North East's five universities in 2016/17 were living in the North East prior to starting their course.

Looking at the destinations of those leaving the North East's five universities in 2016/17:

- 59.1% of UK domiciled leavers that were in employment 6 months after leaving were employed in the North East.
- This increases to 91.1% for students that were living in the North East prior to starting their course.

Whilst data is not publicly available by subject area, this would suggests that there is a strong flow of students from these courses into the North East labour market and economy. The development of degree apprenticeships is providing additional routes for developing the skills required by the advanced manufacturing and digital sectors , with the University of Sunderland having launched a degree apprenticeship in digital and technological solutions. Further degree apprenticeships are in the pipeline, with universities working with local employers and sectoral bodies to develop these programmes. In addition, one of the bids currently being considered for Institutes of Technology is based in the North East. This bid has digital and advanced engineering at its core.

7. Funding for innovation activities to support the SIA sectors

Key messages

Significant funding has already been committed to enhancing local innovation and business growth including over £162 million of Local Growth Fund.

Enterprise Zones support the growth of the industries covered by this SIA by ensuring long-term availability of over 700 hectares of appropriate development sites.

Further investment is required to support cross-sector working and enhanced application of digital technologies to advanced manufacturing.

The next steps identified in Section 8 are considered to be well-aligned with future funding programmes including the Strength in Places Fund and the Industrial Strategy Challenge Fund. Longer term, it is of vital importance that as the Government develops the UK Shared Prosperity Fund that this provides opportunities to build on existing assets and enables future development in relation to innovation in general and the activities outlined in Section 8 in particular.

Introduction

This section will set out the funding and investment that has been used to support the growth and development of the innovation capacity in the North East, with a particular focus on the industries covered by this SIA – automotive, chemical and pharmaceutical manufacturing and digital.

The North East has invested significant amounts into supporting innovation across the SIA sectors. This had been drawn from a range of public and private sources representing a conservative estimate of £363.2m through localised routes since 2012 with a further £772m invested since 2004 through InnovateUK and its predecessor institutions.

Local Growth Fund

Local Growth Fund (LGF) investment has provided a very sizable element of public investment in innovation and business growth activities across the North East. In both the North East LEP and Tees Valley Combined Authority areas, driving innovation in the manufacturing and digital sectors have been highlighted as essential to delivering their respective Strategic Economic Plans and have resulted in over £242.2m investment of which £162.2m was from LGF. This has supported a wide range of skills, business growth and test, demonstration and incubator activities through physical assets. This has included funding for specific centres and assets and wider place-making approaches around innovation or manufacturing such as the Hartlepool Innovation and Skills Quarter and the International Advanced Manufacturing Park (IAMP) in Sunderland and South Tyneside. Figure 7.1 sets out a summary of the main LGF-funded projects in the North East that support the SIA industries (either directly or indirectly).

Figure 7.1: Local Growth Fund funding for SIA-related projects

Project Name	Project cost (£)	LGF contribution (£)
5G Testbed Development Study	250,000	250,000
A1 Junction 61, Bowburn - Integra 61	6,560,640	1,499,537
A19 employment corridor access improvements	5,107,000	4,700,000
Billingham Bio-Pharmaceutical	1,000,000	1,000,000
Boho Next Generation	100,000	100,000
Centre for Innovation in Formulation (CIF)	15,900,000	8,900,000
CPI Healthcare Futures Centre	18,000,000	10,000,000
Development of a STEM Specialist Centre	2,250,000	2,500,000
Durham City Incubator	3,919,500	1,250,000
Explorer - Netpark	7,196,002	3,200,000
Hartlepool College of Further Education – EV Technology and Telecare	165,128	130,020
Hartlepool Innovation and Skills Quarter Phase1	8,279,330	5,500,001
Hartlepool Innovation and Skills Quarter Phase 2	12,640,000	9,840,000
Infrastructure for Forrest Park	13,000,000	13,000,000
International Advanced Manufacturing Park (IAMP)	41,158,000	41,158,000
Jade Business Park (inc A19/A189 Seaham Murton interchange)	3,301,945	3,301,945
Materials Processing Institute	9,280,965	3,050,000
Medicines Manufacturing & Medical Technology Innovation Infrastructure	222,375	212,375
National Centre for Healthcare Photonics (Stage 1)	331,690	211,630
National Centre for Healthcare Photonics (Stage 2)	7,948,431	7,948,431
Netpark Infrastructure Phase 3	5,091,141	5,091,141
Newcastle Laboratory and Life Science Incubation Hub	25,734,414	8,600,000
Northern Centre for Emerging Technologies	7,775,594	968,830
Offshore Wind Validation Centre - Teesside Advanced Manufacturing Park	8,368,554	3,000,000
STEM & Innovation Centre	1,200,000	1,000,000
Sunderland Enterprise & Innovation Hub (FabLab)	8,238,431	4,900,000
Teesside Advanced Manufacturing Park	1,380,000	1,380,000
Teesside Advanced Manufacturing Park	140,000	120,000
Teesside University - National Horizon Centre	22,266,802	17,500,000
Teesside University Innovation and Enterprise Space	1,450,000	950,000
TWI Healthcare Innovation Research Centre	4,985,881	945,000

Source: North East LEP and Tees Valley Combined Authority

European Structural and Investment Funds

The North East has been a major beneficiary from investment through the European Structural and Investment Funds. In both the 'more developed' and 'transitional' areas within the North East, a high proportion of funding has been targeted at innovation activities. The majority of this investment has been aligned to Priority Axis 1 – Innovation although there has also been investment in skills from the European Social Fund. Together this investment is scheduled to be worth £121m with £66.7m of ESIF investment over the 2014-2020 programme bringing in a further £54.3m of matched public and private investment. Current performance in both areas has resulted in strong take up of the funding supporting key strategic projects.

Figure 7.2: European Structural and Investment Funds for SIA-related projects

Name	Project summary	Project cost (£)	ESIF contribution (£)
CIF ESM Outreach	The project will support regional/ national formulation SMEs to extract additional value from enhanced engineered surfaces and materials	2,301,506	1,300,351
Collaborative Outreach in Applied Surface Engineering Technologies (COAST)	COAST supports SMEs offering high-tech products based upon engineered surfaces and advanced polymer composites. Nano-technology and materials know-how will be used to create superior, light-weighted products using bespoke functional particles	4,516,230	2,709,735
Emerging Electronics Manufacturing Centre	Provision of specialist equipment and staff - enable local SMEs, businesses and universities to access facilities and expertise for development industrial and consumer products	4,553,600	2,595,800
Hope Street Xchange	New build centre - to accommodate businesses seeking to collaborate with university, develop products and support student start ups	4,612,450	2,227,742
IBB Scale Up Capability Programme	This proposal will provide the necessary enhanced capability to de-risk commercialisation of next generation technologies for both start-up and mature SMEs in Industrial Biotechnology (IB)	896,110	537,666
Innovate2Succeed	Support to SMEs to help them enhance their innovation management capability, forms part of a programme being delivered across 13 pilot LEPS	1,000,000	500,000
Innovation Durham	This project will provide an intensive and coherent response to the innovation needs of SMEs. Support will benefit SMEs who have the capability, but lack the absorptive capacity, to innovate and grow by exploiting the opportunities offered	1,150,850	690,511
Innovate Tees Valley	Support to SMEs around innovation and collaboration between sectors, leading to 27 new research collaborations	6,323,207	3,793,924
Newcastle Laboratory (Life Science and Knowledge Cluster)	Build of commercial laboratory facility for SMEs mainly within healthcare and life sciences and promote innovation, products and services	13,941,490	5,166,493
Northern Centre for Emerging Technologies	The Northern Centre for Emerging Technologies project will bring forward specialist workspace and testing facilities (including access to appropriate development kit) to support the development and commercialisation of emerging technologies	8,054,113	3,240,880
North East Innovation Supernetwork	Support to SMEs to innovate through collaboration with other SMEs and wider networks	1,017,877	521,439
Northern Accelerator	The objective is to create 15 high technology spin-out companies over the three year period	899,385	481,698
SME SPOTLIGHT - Photonics and Emerging Technologies for Healthcare SME Support Programme	CPI and Durham University will deliver this project through a seamless, synergistic offering, combining their knowledge, and research and innovation facilities	1,414,641	848,784
The Innovation Pathway	Increase competitiveness of SMEs in healthcare sector through programme of support for development of new products	2,018,175	1,033,631

Source: MHCLG

Enterprise Zone sites

The North East is home to 33 Enterprise Zone sites covering 719 hectares. These sites provide businesses with direct benefits in the form of Enhanced Capital Allowance or Business Rate Relief in addition to up-front site development investment which ensures that sites are fit for purpose. Across the North East, these sites support a range of sectors with a number of sites specifically focused at the advanced manufacturing and related logistics sectors to support growth. A list of all Enterprise Zone sites in the North East is given in Appendix 5.

Innovate UK and national funding

Innovate UK funding has been one of the major sources of investment for innovation projects in the North East. Since 2004, over £772m has been investment in 1,165 projects in the North East. This figure includes significant investment in national infrastructure and facilities such as the Offshore Renewable Catapult facility in Blyth. The 'manufacturing and material' and 'infrastructure' themes are particularly prevalent in the North East (both in terms of number of projects and size of investment), attracting a relatively high proportion of national expenditure. Compared to other themes, the 'emerging and enabling technologies' theme appears to have be driven by a large number of smaller projects.

Figure 7.3: Innovate UK funding, 2004 to 2018, North East

Innovate UK Theme	Number of projects	Value of projects (£)	% of North East projects	% of North East value	% of UK projects	% of UK value
Non-core	30	303,312,272	3	39	1.5	16.8
Manufacturing and materials	293	231,752,668	25	30	4.2	13.7
Infrastructure	204	131,951,949	18	17	4.3	12.8
Health and lifescience	140	60,325,701	12	8	3.8	6.4
Emerging and enabling	483	40,957,023	41	5	3.6	3.1
Development	15	4,196,403	1	1	4.7	4.0
Total	1165	772,496,016	100	100	3.8	11.2

Source: InnovateUK (Updated 16th July 2018)

Through the varied sources of public funding available there has been significant investment in the innovation infrastructure including relating to the application of digital technologies to the manufacturing process. It is clear that this funding could be more closely coordinated and aligned to ensure that the maximum value and complementarity can be achieved. This will be relevant in the shift to new funding routes with clear potential sources of investment in the application of digital technologies into advanced manufacturing within forthcoming investment funds such as the Industrial Strategy Challenge Fund and Strength in Place funding. The actions set out in the next chapter (Section 8) are considered a good match to these sources. Longer term, it is of vital importance that as the Government develops the UK Shared Prosperity Fund that this provides opportunities to build on existing assets and enables future development in relation to innovation in general and the activities outlined in Section 8 in particular.

8. Conclusions

Key messages

The SIA process has confirmed the individual strengths and growth potential in automotive, chemical and pharmaceutical manufacture in the North East and the UK more widely. Evidence of a relevant and growing digital sector has also been identified.

There are global opportunities presented through the shift to applied digital technologies to manufacturing processes and products but these also require action to make the most of and ensure the North East and UK keep pace with areas who are already engaging in the shift.

The North East, and more widely the UK, is well placed to draw on the assets in place to make this shift but there needs to be a more proactive, structure and targeted approach to ensure this happens.

Responding to this evidence partners have developed a series of priorities which provide a framework for activity. These are being further developed by the newly established partnership into more specific, investable projects.

- Programme of support to enable business to understand and engage with the digitisation of manufacturing processes
- Digitisation and digital manufacturing leadership and skills programme
- Complete and ensures uptake of the Centre in Excellence in Sustainable Advanced Manufacturing across manufacturing sectors
- Improved networks for cross-sector solution development
- Identify areas of technology opportunity and deliver supporting infrastructure.

The findings of the North East SIA show a clear synergy and alignment with the Made Smarter review and recommendations.

Introduction

The findings from the Applied Digital Technologies SIA have shown a clear potential for growth from the use and application of these technologies in the advanced manufacturing sector. Building on these strengths and opportunities, improved manufacturing processes using digital technologies can drive improved productivity through efficiency and responding to market demand for more enabled and complex products.

Through the desk-based research, surveys and workshops a clearer picture of the gaps and required actions emerged. The areas of focus are: leadership, skills and awareness raising alongside test and demonstration facilities and support for roll out. In reaching this conclusion the SIA demonstrates clear synergy with Made Smarter review and the resulting recommendations.

Key findings

The SIA has involved desk-based research, surveys of businesses in the digital and advanced manufacturing sectors and a series of workshops. The workshops have provided additional context and more nuanced perspectives particularly regarding the integration of the two sectors.

The main findings emerging from the desk-based research are:

- Manufacturing plays a critical role in the North East economy, accounting for a larger proportion of GVA and employment than across England or the UK. Within this, automotive, chemicals and pharmaceutical manufacturing form clusters of activity. Supporting these sectors to grow and development will be important for the North East's economy going forward.
- Applied digital technologies will be vital in helping these sectors to innovate, grow and develop. Given the emerging nature of these technologies, it is not possible to measure the scale of the applied digital technologies sector in the North East directly. Data on the wider 'information and communications' sector indicate that whilst this sector accounts for a smaller proportion of GVA and employment in the North East than England or the UK as a whole, it has experienced a period of significant growth.
- The market drivers in relation to the development of applied digital technologies for advanced manufacturing include:
  - Automotive manufacturing – desire for more connected supply chains; desire from OEMs to future-proof manufacturing facilities; rapid expansion in global connectivity; changing consumer markets; and rising labour costs.
  - Chemicals manufacturing – mitigating supply chain risks; more efficient data management; safety management; and growing international competition in the sector.
  - Pharmaceutical manufacturing – tackling counterfeiting; product traceability; rise of individualised medicines; increased regulation; and recognition of efficiency gains.
- Given that the global market for applied digital technologies for these three sectors are projected to be in the hundreds of billions within the next 2-3 years, helping bring together digital businesses in the North East with the region's advanced manufacturing businesses to develop applications is a major opportunity to grow this sector's size and contribution to the local and national economy.
- Businesses in the digital and advanced manufacturing sectors in the North East are supported by a wide range of science and innovation assets including:
  - Applied digital technologies – Sunderland Software City; Digital Catapult North East and Tees Valley; National Innovation Centre for Data; Advanced Research Computing, Durham University; Northumbria University BIM Academy; University of Sunderland – Faculty of Computer Science; Digital City; Digital Union; Dynamo; VRTGO Labs/Proto Lab; BOHO; HM Revenue and Customs Digital Delivery Centre; and NHS Business Services Authority
  - Automotive manufacturing – North East Automotive Alliance; Zero Carbon Future; Automotive and Manufacturing Advanced Practice Centre, Sunderland University; A19 Enterprise Zone and IAMP; Centre of Excellence in Sustainable Advanced Manufacturing; and Gateshead College – SASMI
  - Chemicals manufacturing – North East Process Industry Cluster (NEPIC); Materials Processing Institute; TWI; Technology Futures Institute; and Centre for Process Innovation – Graphene Applications Centre
  - Pharmaceutical manufacturing – First for Pharma; NEPIC; and Centre for Process Innovation – National Biologics Manufacturing Centre and National Formulation Centre; and Newcastle Laboratory
  - Multiple sectors and wider ecosystem – High Value Manufacturing Catapult; Innovation SuperNetwork; NETPark; Northern Design Centre; Newcastle Helix; Advanced Manufacturing Science Park; North East Fund; Northern Powerhouse Investment Fund; Northern Accelerator; and Design Network North

The large number of assets – alongside their breadth of activities – will help the North East develop a cluster in relation to applied digital technologies for advanced manufacturing.

Gap analysis through surveys and workshops

One of the main challenges in taking forward this SIA has been understanding the interrelationship and use of digital within manufacturing businesses as this is not captured in existing data. By engaging with business and sectoral organisations from both the advanced manufacturing and digital sectors, through surveys and workshops we have identified a number of gaps that are currently holding back the adoption and roll-out of the technologies. Whilst there appear to be a number of digital strategies in place these are often at a corporate level and do not accurately reflect process and manufacturing issues or specifically relate to a facility. This is accompanied by a perceived lack of digital leadership and embedded understanding around digitisation within the manufacturing sector/understanding of needs of manufacturing businesses in digital businesses. Outside of some positive examples by Sunderland Software City, Digital City and the Innovation SuperNetwork there is scope to expand this approach into more systematic relationships between the sectors to explore and investigate opportunities for alignment. In understanding this, the value of localised clusters and cross-sector networks has been highlighted as an important element to provide comfort over the risks around a roll-out of a new technology. This understanding has been refined to identify a series of gaps which require additional focus to address including actions around:

Raising awareness and understanding of digital technologies

- Developing a shared language across the advanced manufacturing and digital sectors to better articulate the opportunities applied digital technologies offer to advanced manufacturing and the barriers to uptake.
- Raising awareness of the opportunities, potential and importance of the application of digital technologies for advanced manufacturing.
- Improving the understanding of senior managers within advanced manufacturing businesses of the scope and value of digital technologies and supporting them to act as champions for digital technologies within their organisations.

Skills and training

- Enhancing current provision to ensure the digital skills required by the advanced manufacturing and digital sectors in the North East are available. This includes the development of skills of those joining the labour market for the first time, the current advanced manufacturing and digital workforces and those reskilling.
- Building on existing programmes to provide opportunities for teachers to spend time in the digital and advanced manufacturing sectors to raise their understanding of the skills needs of these sectors, including the importance of digital skills. This will enable them to bring this knowledge and understanding into the curriculum.
- Making use of digital technologies (including virtual reality and augmented reality) to undertake training and skills development within advanced manufacturing (for example, to train workers in advance of a roll-out of a new production line).

Facilities and networks

- Upgrading and expanding test and demonstration facilities to allow prototyping and testing of new approaches and techniques (including through the Centre of Excellence in Sustainable Advanced Manufacturing).
- Supporting cross-sector innovation, sharing success and awareness so that other businesses are made aware of the potential benefits.

Business support and growth

- Tailor and active support for businesses in both the digital and advanced manufacturing sectors to help them understand and access near-to-market opportunities.
- Supporting businesses to utilise digital technologies to improve real-time information regarding their supply chains. With changing formulations and source materials, this gap is also highlighted in the chemicals and processing SIA.

Target opportunities and ambition

Partners have been engaged through a set of workshops to develop projects which support delivery of the vision and respond to the opportunities. Nearly 30 actions were proposed as responding to the challenges and opportunities identified by the for Applied Digital Technologies SIA. These have been assessed and prioritised by SIA partners, with areas of overlap brought together into a series of ambitions which will respond to the gaps set out below. These will be further developed by the partnership, putting the SIA into practice and enabling the North East to achieve the identified potential.

The agreed ambition is to:

- Put the North East at the forefront of process innovation for manufacturing with assets and support in place to ensure digital process improvements are business-ready and easily implemented by all North East manufacturing businesses. This would minimise cost implications and the practical challenges of trial and development which deter take up alongside support to understanding the benefits of and reduced costs of implementation for digital technologies in manufacturing.

Action plan

In considering how best to deliver these ambitions, a wide range of projects were considered. Potential funding routes for each project have also been considered with scope for significant industry participation and input alongside public interventions. Whilst we understand that there is not an automatic or guaranteed link between the work of the Science and Innovation Audit and any particular funding route, there is a clear potential for investment in elements of the action plan through the Industrial Strategy Challenge Fund and Strength in Place funding alongside other public and private sources. This investment is required for medium-term competitiveness to be maintained across the advanced manufacturing sectors and to place North East and UK firms at the forefront of a global market with very significant potential for expansion and growth.

Each of the ambitions set out below is essential to deliver productivity improvements and economic growth. The projects focus on building the physical and virtual infrastructure needed to support the integration of digital technologies into areas of manufacturing strength. To achieve this we have included activities to support process innovation, the components required to enable new integrated products, specifically around small batteries, and the skills, finance and test/demonstration facilities required. In each case, developing and adopting these will enhance existing regional strengths. Together, they will represent an effective, strategic step change supported by a raft of wider initiatives and sector specific projects. The proposals will be integrated into the wider local ecosystem.

Complete and ensure uptake of the Centre of Excellence in Sustainable Advanced Manufacturing (CESAM) across manufacturing sectors.

The proposed CESAM project can provide a new hub for activity across the manufacturing sectors to support the next generation of factories and manufacturing processes to be developed, tested and implemented. During the SIA process the scope for broadening the project from an initial automotive focus to the wider sector has become clear. This would include working with national programmes and projects in related areas.

Programme of support to enable business to understand and engage with the digitisation of manufacturing process.

A gap in organisational understanding of the scope and opportunities around digitalisation in the manufacturing process was identified. A programme of business supports around this with direct mentoring and one-to-one support alongside wider awareness raising is needed to facilitate uptake and integration of the new technologies and approaches.

Digitalisation and digital manufacturing leadership and skills programme.

This includes work with universities, schools, colleges and other skill providers to tailor programmes and short courses to meet skills demand including up- and re-skilling across different age groups. A supporting programme of digital leadership should be included.

Improved networks for cross-sector solution development.

Despite existing examples of good practice, there is a need to expand from the current provision to bring together a tailored approach to networking between digital and advanced manufacturing. This will draw on good practice in Sunderland Software City and Innovation SuperNetwork and other local partners where to ensure there is a strong and consistent understanding of opportunities, challenges and potential and a shared language.

Identify areas of technology opportunity and deliver supporting infrastructure.

A number of specific technology areas have been identified as being relevant to the digitalisation of manufacturing and relevant local strengths. To support the embedding of the digital technologies the appropriate supporting infrastructure to develop, test, demonstrate and roll-out these technologies is required. Through the SIA process, specific opportunities have been identified in relation to on-board technologies for automotive and for personalisation and smart-packaging for pharmaceuticals.

Networking and collaboration

By its nature a SIA, focusing on the integration and application of technologies and techniques from one area (digital) to another (advanced manufacturing) and by drawing together partners across sectors (automotive, pharmaceutical and chemicals) has shown potential for new collaborations and improved networks.

Through the partnership the beginnings of a longer-term alliance of interested and engaged partners is being built to support practical delivery of the resulting actions. This has been supported through two primary routes:

- A Steering Group was established for the SIA with representatives from sectoral bodies, universities and LEPs brought together to facilitate the development process. This has enhanced the connections between partners and led to new insights and relationships.
- Through the partner workshops that brought together the wider partners to develop the work plan. Further workshop is planned to initiate the process of moving the SIA partnership to a longer-term approach. It is anticipated that this will be cross-sector to provide maximum connections and opportunities but will also facilitate smaller scale activities between specific elements of the partnership.

In supporting this, we are able to build on existing relationships and mechanisms to support interaction including the Innovation SuperNetwork and the growth hubs. These provide routes to continue and expand engagement across the sectors and organisations

Next steps

The delivery of the SIA has brought together a new set of partners to support the delivery. This is intended to be a starting point for long-term development and actions. As part of the process we have therefore established a route and process for undertaking the next steps in developing and delivering the proposed interventions and actions.

This will be undertaken in a collaborative approach through the partnership. Following on from the completion of this report, a dedicated workshop will both launch the findings to the full set of stakeholders in the North East as well as initiating the continuation of the partnership in a new form, focused on the delivery of the works treams through more specific activities.

Work to facilitate specific projects such as the Centre of Excellence in Sustainable Advanced Manufacturing and enhancements to existing projects such as the InnovationSupernetwork are already being developed drawing on local resources to prepare for larger external sources of funding.

Appendices

Appendix 1: Overview of North East economy

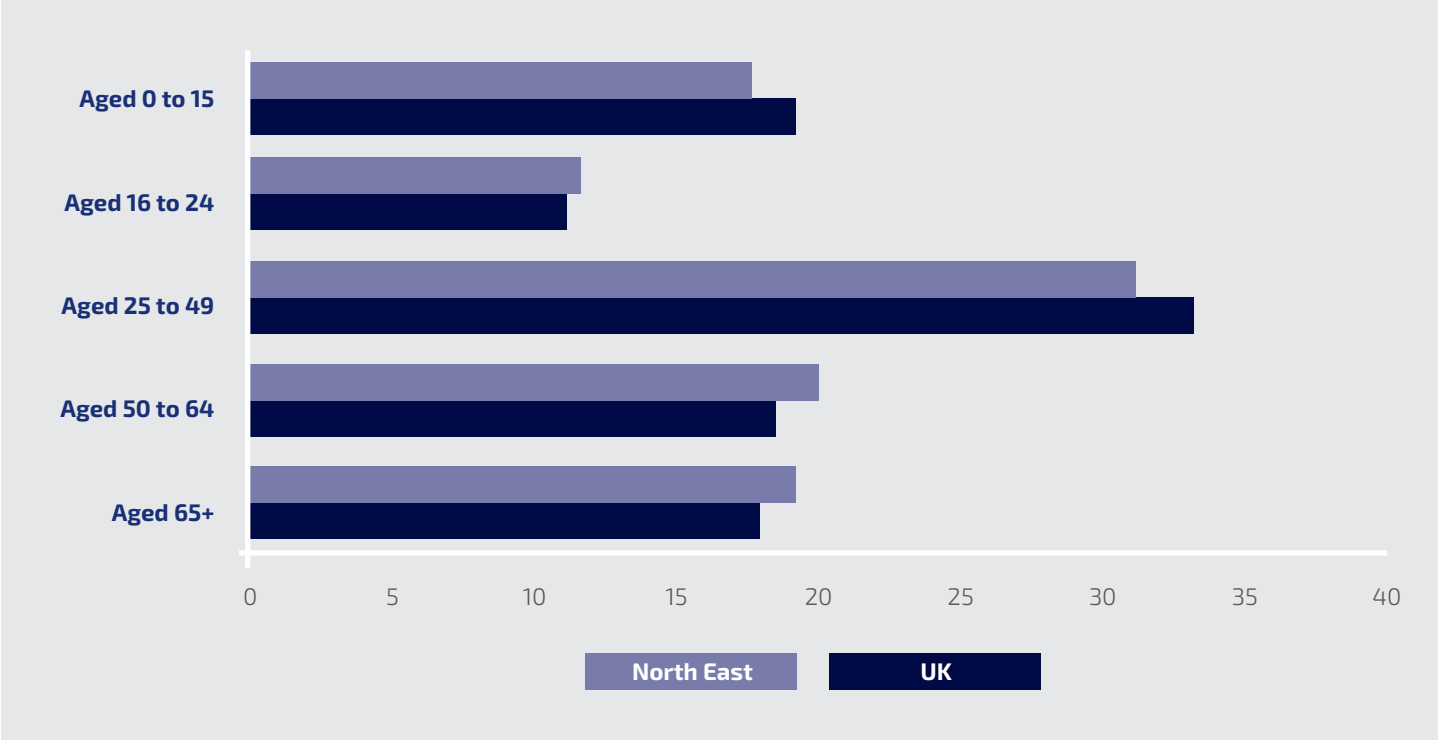
Population

The population of the North East was 2.6 million in 2016.[107] The working age population (16-64) was 1.6 million. Whilst a similar proportion of the North East population as the UK are working age (63.0% compared to 63.1%), there are a number of differences in the population structure with:

- A smaller proportion of the population in the 0-15 and 25-49 age bands
- A larger proportion of the population in the 16-24, 50-64 and 65+ age bands.

Linked to this older age profile, the North East's working age population is projected to decline by 2.2% between 2016 and 2026, compared to a 3.0% increase across England[108] (UK data not available).

Figure A1.1: Breakdown of population by age band (% of total), North East and UK, 2016



Source: Population estimates - local authority based by single year of age (Nomis)

Employment

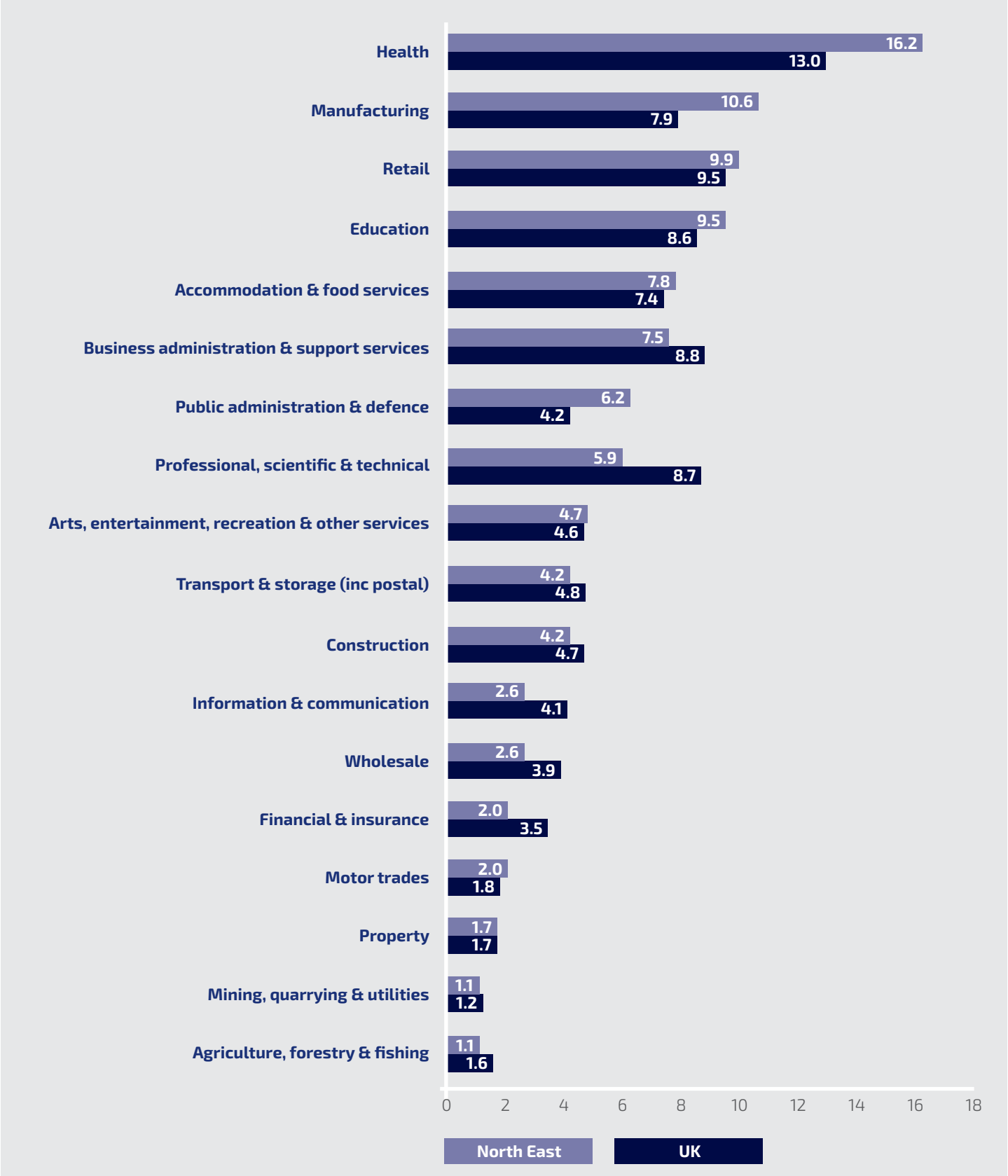
There were 1,076,000 jobs in the North East in 2016.[109] This is equivalent to 648 jobs per 1,000 working age population, compared to 753 across Great Britain as a whole (UK data is not available).

Looking at employment by sector.[110]

- Similar to Great Britain as a whole, the health sector is the largest employer in the North East, with 16.2% of employment in this sector
- The second largest employer in the region is manufacturing, which accounts for 10.6% of employment. Manufacturing accounts for a larger proportion of employment in the North East than nationally
- Employment in information and communications (a broad sector which includes many of those employed in digital) was 2.6% of the total, a smaller proportion than across Great Britain (4.1%).

107 Population estimates – local authority based by single year of age (Nomis)
108 Population projections – local authority based by single year of age (Nomis)
109 Business Register and Employment Survey (BRES) (Nomis)
110 Business Register and Employment Survey (BRES) (Nomis)

Figure A1.2: Breakdown of employment by broad sector, North East and Great Britain, 2016



Source: Business Register and Employment Survey (Nomis)

Qualifications

The North East has a lower qualifications profile than the UK[111] in 2017 with:

- Fewer individuals with Level 4 or above qualifications – 31.7% compared to 38.4%
- More individuals with no qualifications – 9.6% compared to 8.0%.

However, the North East has made significant progress in recent years. The proportion qualified to Level 4 or above has increased from 26.8% in 2012. The increase (4.8 percentage points) is larger than the increased observed across the UK (4.4 percentage points).

Productivity and earnings

Productivity is lower in the North East than nationally.[112] In 2016:

- Gross Value Added (GVA) per hour worked was £29.00 in the North East, compared to £32.60 in the UK (excluding extra-regio)
- GVA per filled job was £45,542 in the North East, compared to £52,626 in the UK (excluding extra-regio).

Reflecting the lower levels of productivity, the North East also has lower average earnings.[113]

- Average (median) wages of full-time workers in the North East were £504.10 in 2017, compared to £550.40 across the UK
- These figures are the same for both the workplace and resident analysis.

Business base

In 2016, there were 74,115 active enterprises in the North East region.[114]

- This is equivalent to 28.1 private sector enterprises for every 1,000 residents in the North East
- This compares to 43.2 across the UK.

In 2016, there were 10,180 business births in the North East region.[115]

- This is equivalent to 3.9 births for every 1,000 residents
- This compares to 6.3 across the UK.

8,530 businesses closed in the North East region during 2016.[116]

- This is equivalent to 3.2 closures for every 1,000 residents in the region
- This is below the UK rate (5.0).

The number of active businesses in the North East is increasing.[117]

- By 3,105 or 4.4% between 2015 and 2016
- By 11,075 or 17.6% between 2011 and 2016.

However, in both cases the rate of growth has been slower than in the UK as a whole.

Combined, these statistics mean that there is a smaller business base in the North East than across the UK as a whole and that it is less dynamic.

Looking at survival rates, of the 9,685 business births in the North East in 2013.[118]

- 94.3% were still active after 1 year
- 74.7% were still active after 2 years
- 60.2% were still active after 3 years.

These rates are similar to the UK – with the North East having a slightly higher survival rate at 1 year but a slightly lower survival rate at years 2 and 3.

111 Annual Population Survey (Nomis)
112 Subregional productivity: Labour productivity indices for UK NUTS2 and NUTS3 subregions (ONS). Both measures are nominal, unsmoothed, balanced GVA.
113 Annual Survey of Hours and Earnings (ASHE) (Nomis)
114 Business demography (ONS)
115 Business demography (ONS)
116 Business demography (ONS)
117 Business demography (ONS)
118 Business demography (ONS)

Figure A1.3: Survival of 2013 business births, North East, England and UK

	Births	1-year survival	1-year per cent	2-year survival	2-year per cent	3-year survival	3-year per cent
North East	9,685	9,130	94.3	7,235	74.7	5,830	60.2
UK	346,485	323,810	93.5	259,995	75.0	210,805	60.8

Source: Business demography (ONS)

Business growth

There is mixed evidence on the North East's performance on business growth.[119]

- The proportion of 2014 start-ups in the North East LEP area that survived to 2017 and were generating more than £1 million in revenues in 2017 (1.7%) is below the UK rate (1.9%). Data is not available for the Tees Valley LEP area on this measure as it is disclosive
- The proportion of North East LEP businesses with turnover of £1 million to £2 million in 2014 that increased turnover to £3 million or more by in 2017 was above the UK average (7.4% compared to 7.2%) – but the Tees Valley LEP rate was below the national average (5.5%)
- When the OECD measure of high growth firms is used, the Tees Valley LEP area had the same proportion as the UK as a whole (6.3%) – whilst the North East LEP had a lower rate at 5.6%
- The North East LEP has the same incidence of small high growth firms as the UK as a whole – with 1.5% of the North East LEP's businesses being defined in this way. In contrast, Tees Valley LEP area is underperforming on this measure (1.2%).

Gross Value Added

Gross Value Added (GVA) is the value of the goods and services produced in a region or sector minus any intermediate goods and services. The GVA of the North East was £50.7 billion in 2016 (using the balanced measure of GVA), accounting for 2.9% of UK GVA.[120]

Whilst the value of the North East's GVA has increased by £8.5 billion over the last 10 years, once inflation is stripped out, the GVA of the North East was only marginally higher in 2016 than 2006, whilst GVA had grown by 13.6% across the UK over this period.

119 Enterprise Research Centre (2018). UK Growth Dashboard 2018.
120 Regional Gross Value Added (balanced approach) (ONS)

Appendix 2: Science and research data

Figure A2.1: Submitted outputs, full-time equivalent (FTE) researchers and doctoral degrees awarded, higher education (HE) institutions in North East region, REF 2014

	Outputs			FTE researchers			Doctoral degrees awarded 2008-12		
	No.	%	LQ (compared to UK)	No.	%	LQ (compared to UK)	No.	%	LQ (compared to UK)
Agriculture, veterinary and food science	103	1.26	0.61	25.40	1.15	0.58	84	2.06	1.11
Allied health professions, dentistry, nursing and pharmacy	390	4.78	0.88	103.80	4.71	0.89	179	4.38	0.84
Biological sciences	270	3.31	0.73	69.60	3.16	0.69	180	4.41	0.64
Clinical medicine	562	6.88	0.98	147.13	6.67	0.97	363	8.89	1.09
Psychology, psychiatry and neuroscience	355	4.35	0.91	95.58	4.33	0.90	191	4.68	0.79
Public health, health services and primary care	104	1.27	0.50	27.22	1.23	0.47	45	1.10	0.62
Aeronautical, mechanical, chemical and manufacturing engineering	196	2.40	1.11	55.70	2.53	1.14	180	4.41	1.19
Chemistry	247	3.03	1.23	65.00	2.95	1.25	192	4.70	0.95
Civil and construction engineering	142	1.74	2.40	40.60	1.84	2.45	70	1.71	1.96
Computer science and informatics	288	3.53	0.88	80.40	3.65	0.93	167	4.09	0.93
Earth systems and environmental sciences	234	2.87	1.04	59.41	2.69	1.02	134	3.28	1.26
Electrical and electronic engineering, metallurgy and materials	114	1.40	0.66	31.20	1.41	0.69	170	4.16	1.06
General engineering	216	2.65	0.58	70.00	3.17	0.68	116	2.84	0.50
Mathematical sciences	332	4.07	1.11	88.40	4.01	1.08	115	2.82	1.07
Physics	293	3.59	1.06	74.55	3.38	1.03	141	3.45	0.92

Source: Compiled by Technopolis based on 2014 REF results (HEFCE)

Figure A2.2: % of research in each category (weighted averages), HE institutions in North East region and UK, REF 2014

	4*	3*	2*	1*	Unclassified
Agriculture, veterinary and food science					
• North East	17.5	39.8	41.7	1.0	0.0
• UK average	18.2	50.7	27.7	2.6	0.8
Allied health professions, dentistry, nursing and pharmacy					
• North East	14.5	52.5	30.8	2.3	0.0
• UK average	21.4	55.7	20.1	1.9	0.9
Biological sciences					
• North East	28.9	45.0	23.2	0.7	2.2
• UK average	29.3	48.9	19.1	1.3	1.4
Clinical medicine					
• North East	18.3	56.4	22.8	1.8	0.7
• UK average	23.1	53.5	21.3	1.1	1.0
Psychology, psychiatry and neuroscience					
• North East	21.7	48.5	26.3	2.7	0.9
• UK average	25.9	45.8	24.6	3.0	0.7
Public health, health services and primary care					
• North East	14.4	46.2	36.5	2.9	0.0
• UK average	22.6	48.6	25.0	3.1	0.7
Aeronautical, mechanical, chemical and manufacturing engineering					
• North East	20.1	45.7	33.2	1.1	0.0
• UK average	18.0	60.4	20.7	0.8	0.1
Chemistry					
• North East	16.0	72.9	11.2	0.0	0.0
• UK average	22.1	69.4	8.1	0.2	0.2
Civil and construction engineering					
• North East	19.7	62.0	17.6	0.7	0.0
• UK average	18.1	58.0	19.3	4.3	0.3
Computer science and informatics					
• North East	14.5	49.5	27.9	7.9	0.3
• UK average	22.1	47.1	25.8	4.8	0.2
Earth systems and environmental sciences					
• North East	16.3	65.1	18.7	0.0	0.0
• UK average	18.2	60.7	18.9	2.0	0.2
Electrical and electronic engineering, metallurgy and materials					
• North East	22.8	71.1	6.1	0.0	0.0
• UK average	19.7	67.7	11.3	1.1	0.2
General engineering					
• North East	9.6	70.9	19.6	0.0	0.0
• UK average	17.2	65.8	15.5	1.0	0.5
Mathematical sciences					
• North East	15.1	60.7	22.9	0.7	0.6
• UK average	22.7	59.7	16.8	0.6	0.2
Physics					
• North East	21.8	72.4	5.5	0.3	0.0
• UK average	21.3	66.6	11.3	0.5	0.3

Source: Compiled by Technopolis based on 2014 REF results (HEFCE)

Figure A2.3: % of research rated 4*, HE institutions in North East region, REF 2014

	Durham	Newcastle	Northumbria	Teeside	Sunderland	UK average
Agriculture, veterinary and food science		17.5				
Allied health professions, dentistry, nursing and pharmacy		17.8	18.0	7.5	10.1	21.4
Biological sciences	15.0	46.6				29.3
Clinical medicine		18.3				23.1
Psychology, psychiatry and neuroscience	16.0	28.4	10.9			25.9
Public health, health services and primary care		14.4				22.6
Aeronautical, mechanical, chemical and manufacturing engineering		25.0			2.5	18.0
Chemistry	23.0	4.2				22.1
Civil and construction engineering		19.7				18.1
Computer science and informatics	20.3	25.0	9.7	4.7	0.0	22.1
Earth systems and environmental sciences	17.0	15.2				18.2
Electrical and electronic engineering, metallurgy and materials		22.8				19.7
General engineering	4.9		18.2	6.4		17.2
Mathematical sciences	13.2	25.6	7.1			22.7
Physics	21.8					21.3

Source: Compiled by Technopolis based on 2014 REF results (HEFCE)

Figure A2.4: Research funded by Research Councils, North East region, 2007 to 2017

	No. of projects	% of projects	Value of projects (£ millions)	% of value
Arts and Humanities Research Council (AHRC)	250	9.8	33.45	3.59
Biotechnology and Biological Sciences Research Council (BBSRC)	340	13.33	93.81	10.05
Engineering and Physical Sciences Research Council (EPSRC)	617	24.19	345.65	37.04
Economic and Social Research Council (ESRC)	203	7.96	50.67	5.43
Medical Research Council (MRC)	145	5.68	118.1	12.66
Natural Environment Research Council (NERC)	275	10.78	54.05	5.79
Science and Technology Facilities Council (STFC)	165	6.47	86.03	9.22
Innovate UK	535	20.97	151.35	16.22

Source: Compiled by Technopolis based on RCUK Gateway to Research

Figure A2.5: Top 20 research subjects by funding awarded, North East region, 2007 to 2017

	No. of projects	Funding (£ millions)	% of UK funding	LQ (compared to UK)
Energy	79	46.2	7.50	2.56
Information and communications technologies	134	40.5	3.14	1.07
Astronomy – observation	58	29.9	9.02	3.07
Civil engineering and built environment	46	28.7	10.51	3.58
Materials sciences	80	19.9	3.67	1.25
Geosciences	143	18.0	7.03	2.40
Particle physics – experiment	27	15.6	3.79	1.29
Chemical synthesis	52	11.5	4.56	1.56
Atomic and molecular physics	23	11.0	4.09	1.40
Medical and health interface	39	10.0	3.01	1.03
Astronomy – theory	17	9.4	20.38	6.95
Optics, photonics and lasers	21	8.1	3.11	1.06
Superconductors, magnetic and quantum fluids	23	8.0	4.52	1.54
Process engineering	33	7.5	3.91	1.33
Tools, technologies and methods	80	6.5	1.92	0.65
Environmental engineering	19	6.5	16.86	5.75
Chemical measurement	29	6.4	3.88	1.32
Mathematical sciences	45	5.7	1.43	0.49
Catalysis and surfaces	46	5.7	2.57	0.88
Climate and climate change	77	4.8	2.62	0.89

Source: Compiled by Technopolis based on RCUK Gateway to Research

Figure A2.6: Income from international sources, HE institutions in North East region, 2008 to 2012

	Income (£ million)	% of international income received by North East HEIs	LQ (compared to UK)
Agriculture, veterinary and food science	5.32	5.50	1.69
Allied health professions, dentistry, nursing and pharmacy	3.43	3.55	0.91
Biological sciences	8.15	8.42	0.80
Clinical medicine	19.86	20.52	0.88
Psychology, psychiatry and neuroscience	1.59	1.65	0.34
Public health, health services and primary care	3.03	3.13	0.35
Aeronautical, mechanical, chemical and manufacturing engineering	13.96	14.42	2.60
Chemistry	5.99	6.19	1.19
Civil and construction engineering	3.28	3.39	3.80
Computer science and informatics	7.34	7.58	1.13
Earth systems and environmental sciences	8.66	8.95	1.78
Electrical and electronic engineering, metallurgy and materials	2.71	2.79	0.57
General engineering	3.51	3.63	0.44
Mathematical sciences	0.70	0.73	0.39
Physics	9.25	9.56	1.86

Source: Compiled by Technopolis based on 2014 REF results (HEFCE)

Appendix 3: Research organisations listed on Global Research Identifier Database (GRID)

Name	Location
Hospitals and NHS trusts	
Wansbeck General Hospital	Ashington
Cw Private Hospital	Ashington
Richardson Hospital	Barnard Castle
Bishop Auckland Hospital	Bishop Auckland
Auckland Park Hospital	Bishop Auckland
Blyth Community Hospital	Blyth
Shotley Bridge Hospital	Consett
Northumbria Specialist Emergency Care Hospital	Cramlington
Darlington Memorial Hospital	Darlington
Tees, Esk and Wear Valleys NHS Foundation Trust	Darlington
West Park Hospital	Darlington
Woodlands Hospital	Darlington
Hundens Lane Day Hospital	Darlington
University Hospital of North Durham	Durham
Chester Le Street Hospital	Durham
Earls House Hospital	Durham
Queen Elizabeth Hospital	Gateshead
Bensham Hospital	Gateshead
Dunston Hill Hospital	Gateshead
Dryden Road Clinic	Gateshead
Gateshead Health NHS Foundation Trust	Gateshead
Guisborough Primary Care Hospital	Guisborough
Haltwhistle War Memorial Hospital	Haltwhistle
University Hospital of Hartlepool	Hartlepool
Hexham General Hospital	Hexham
Monkton Hall Hospital	Jarrow
Palmer Community Hospital	Jarrow
Primrose Hill Hospital	Jarrow
North Riding Infirmary	Middlesbrough
James Cook University Hospital	Middlesbrough
West Lane Hospital	Middlesbrough
Carter Bequest Primary Care Hospital	Middlesbrough
South Tees Hospitals NHS Foundation Trust	Middlesbrough
Morpeth Cottage Hospital	Morpeth
Rothbury Community Hospital	Morpeth
St Georges Hospital	Morpeth
Newcastle Hospitals - Campus for Ageing and Vitality	Newcastle upon Tyne
Freeman Hospital	Newcastle upon Tyne
Princess Mary Maternity Hospital	Newcastle upon Tyne
Royal Victoria Infirmary	Newcastle upon Tyne
Newcastle upon Tyne Hospitals NHS Foundation Trust	Newcastle upon Tyne
Nuffield Health Newcastle upon Tyne Hospital	Newcastle upon Tyne
Newcastle Dental Hospital	Newcastle upon Tyne
St Nicholas Hospital	Newcastle upon Tyne
Northumberland, Tyne and Wear NHS Foundation Trust	Newcastle upon Tyne
Great North Children's Hospital	Newcastle upon Tyne
Walkergate Park Hospital	Newcastle upon Tyne
North Tyneside General Hospital	North Shields

Name	Location
Northumbria Healthcare NHS Foundation Trust	North Shields
Prudhoe Hospital	Prudhoe
Redcar Primary Care Hospital	Redcar
County Durham and Darlington NHS Foundation Trust	Seaham
South Tyneside District Hospital	South Shields
South Tyneside NHS Foundation Trust	South Shields
University Hospital of North Tees	Stockton-on-Tees
Norton Medical Centre	Stockton-on-Tees
Sedgefield Community Hospital	Stockton-on-Tees
North Tees and Hartlepool NHS Foundation Trust	Stockton-on-Tees
Sunderland Royal Hospital	Sunderland
Sunderland Eye Infirmary	Sunderland
Monkwearmouth Hospital	Sunderland
Hopewood Park Hospital	Sunderland
City Hospitals Sunderland NHS Foundation Trust	Sunderland
Sir G B Hunter Memorial Hospital	Wallsend
Businesses	
Thermacore (United Kingdom)	Ashington
Drager (United Kingdom)	Blyth
Thomas Swan (United Kingdom)	Consett
Ionbond (United Kingdom)	Consett
Vastrata (United Kingdom)	Corbridge
Femeda (United Kingdom)	Cramlington
Air Fuel Synthesis (United Kingdom)	Darlington
EMS (United Kingdom)	Darlington
Essex and Suffolk Water (United Kingdom)	Durham
Northumbrian Water Group (United Kingdom)	Durham
Reinnervate (United Kingdom)	Durham
Durham Foods (United Kingdom)	Durham
Petards (United Kingdom)	Gateshead
PrismTech (United Kingdom)	Gateshead
Turbo Power Systems (United Kingdom)	Gateshead
Bastion (United Kingdom)	Gateshead
Prozomix (United Kingdom)	Haltwhistle
Vertellus Specialties (United Kingdom)	Middlesbrough
Natural Synergies (United Kingdom)	Middlesbrough
Safinah (United Kingdom)	Morpeth
Pharma Nord (United Kingdom)	Morpeth
Danaher (United Kingdom)	Newcastle upon Tyne
Demuris (United Kingdom)	Newcastle upon Tyne
Timescape Surveys	Newcastle upon Tyne
Osys Technology	Newcastle upon Tyne
Alcyomics (United Kingdom)	Newcastle upon Tyne
BioTransformations (United Kingdom)	Newcastle upon Tyne
Home Group (United Kingdom)	Newcastle upon Tyne
Isos Housing (United Kingdom)	Newcastle upon Tyne
Limbs Alive (United Kingdom)	Newcastle upon Tyne
Napper Architects (United Kingdom)	Newcastle upon Tyne
Peacocks Medical Group (United Kingdom)	Newcastle upon Tyne

Name	Location
Orla Protein Technologies (United Kingdom)	Newcastle upon Tyne
OJ-Bio (United Kingdom)	Newcastle upon Tyne
QuantuMDx (United Kingdom)	Newcastle upon Tyne
Northern Powergrid (United Kingdom)	Newcastle upon Tyne
Biosignatures (United Kingdom)	Newcastle upon Tyne
Husqvarna (United Kingdom)	Newton Aycliffe
Manus Neurodynamica (United Kingdom)	North Shields
Monitor Coatings (United Kingdom)	North Shields
Castolin Eutectic (United Kingdom)	North Shields
Epigem (United Kingdom)	Redcar
Kromek (United Kingdom)	Sedgefield
Polyphotonix (United Kingdom)	Sedgefield
Crabbe Consulting	Stockton-on-Tees
Carroll & Meynell Transformers (United Kingdom)	Stockton-on-Tees
RTC North (United Kingdom)	Sunderland
Fullwell Mill (United Kingdom)	Sunderland
Gentoo (United Kingdom)	Sunderland
Nissan (United Kingdom)	Sunderland
Viper RF (United Kingdom)	Sunderland
Colleges	
Bishop Auckland College	Bishop Auckland
Darlington College	Darlington
Gateshead College	Gateshead
Hartlepool College of Further Education	Hartlepool
Middlesbrough College	Middlesbrough
Newcastle College	Newcastle upon Tyne
Redcar & Cleveland College	Redcar
South Tyneside College	South Shields
Sunderland College	Sunderland
Universities	
Durham University	Durham
Teikyo University of Japan in Durham	Durham
New College Durham	Durham
Teesside University	Middlesbrough
Newcastle University	Newcastle upon Tyne
Northumbria University	Newcastle upon Tyne
University of Sunderland	Sunderland
Research institutes and Catapults	
National Renewable Energy Centre	Blyth
Offshore Renewable Energy Catapult	Blyth
Wellcome Trust Centre for Mitochondrial Research	Newcastle upon Tyne
NIHR Newcastle Biomedical Research Centre	Newcastle upon Tyne
Biosystems Informatics Institute	Newcastle upon Tyne
Cultural institutions	
Beamish Museum	Durham
Baltic Centre for Contemporary Art	Gateshead
Sage Gateshead	Gateshead
Equal Arts	Gateshead
Tyne and Wear Archives and Museums	Newcastle upon Tyne
Cafe Scientifique	Newcastle upon Tyne

Name	Location
Learned societies	
British Society for Middle Eastern Studies	Durham
Quaternary Research Association	Durham
British Association of Public Safety Communications Officials	Newcastle upon Tyne
VASCOG Society	Newcastle upon Tyne
British Society for Eighteenth-Century Studies	Newcastle upon Tyne
Local authorities	
Northumberland County Council	Alnwick
Durham County Council	Durham
Newcastle City Council	Newcastle upon Tyne
Redcar and Cleveland Borough Council	Redcar
Charities and foundations	
Centre for Life	Newcastle upon Tyne
Northern Counties Kidney Research Fund	Newcastle upon Tyne
Children's Foundation	Newcastle upon Tyne
JGW Patterson Foundation	Newcastle upon Tyne
The Neurosciences Foundation	Newcastle upon Tyne
Industry bodies	
North East of England Process Industry Cluster (United Kingdom)	Sunderland
Shipbuilders & Shiprepairers Association	Sunderland

Source: Global Research Identifier Database (GRID). Extracted on 10 April 2018.
Notes: List includes research organisations listed on GRID on date of extract. Should not be considered full list of organisations in the North East that undertake research or of the organisations in each category. For example, not all universities, colleges or Catapults in the North East are listed on GRID.

Appendix 4: Assets case studies

Science and innovation asset - digital: Sunderland Software City and Digital Catapult in the North East and Tees Valley

Sunderland Software City was formed in 2008 and aims to strengthen the region's economy by helping individual companies to grow create jobs and attract investment. Through collaboration with partners across the UK, they also aim to champion North East tech. Sunderland Software City is part financed by the European Regional Development Fund. Since its inception, it has supported over 500 aspiring and established software businesses in the North East region through the provision of tailored business support services, free, funded or commercial training solutions and by supporting the development of digital technology skills in the region. Sunderland Software City actively represents the sector, leads the consortium for the Digital Catapult Centre North East & Tees Valley, and collaborates with organisations such as the Tech City UK and Tech North to deliver new initiatives that accelerate the development of the region's software economy. The Digital Catapult structure is based on three spokes in addition to the central hub. As one of the three of these spokes the Digital Catapult North East and Tees Valley provides a clear asset in linking the digital sector to wider industries and supporting economic growth.

Science and innovation asset – digital: National Innovation Centre for Data

The National Innovation Centre for Data was established to help address this by improving organisations' utilisation of data. The Centre received £15 million from Government (awarded late 2017), with matched funding from Newcastle University. This expands on the previous Cloud Innovation Centre with since its establishment in 2015 has engaged 3,000 individuals and provided advice to 200 companies. The Centre's remit is to assist organisations to improve their utilisation of data and therefore improve productivity. In particular, it will:

- Highlight the importance and relevance of data to students, the general public, technical staff and management teams
- Improve the data analytic skills available to organisations by signposting them to sources of skills and by upskilling their staff.

This will be achieved through a flexible rolling programme of collaborative projects focussed on organisations' specific challenges and opportunities transferring practical data skills into the workforce of those organisations. These projects will be supported by a range of related activities, including awareness raising events, themed business and technical seminars and technical training courses. The result of engagement with NICD will be to enable organisations to increase their productivity by optimising their existing operations, and to grow by launching new data-driven products and services. The Centre's building and operations are primarily funded by Central Government and Newcastle University. Projects and certain events will require partial funding by clients.

Science and innovation asset – digital: Advanced Research Computing, Durham University

Durham University established an Institute of Advanced Research Computing in 2014. Subsequently it was awarded status as an Intel Parallel Computing Centre and an NVIDIA CUDA research centre, as part of the aim to develop research partnerships between Durham University and industry in the field of High Performance Computing. The aims of ARC are:

- Pool together critical mass of researchers from different disciplines to form connected research communities around common problems or technologies
- Foster cross disciplinary collaboration and promote cutting edge transformative multi-disciplinary research projects
- Undertake long-term relationship building with external partners in academia, government and industry to accelerate innovation and identify pathways to impact.

The main activities of the ARC include High-Performance Computing (HPC) but are not limited to it. For example, the storage and manipulation of large datasets is also undertaken. Contemporary applications are satellite images, the data pipelines from laboratory equipment such as sequencers and microscopes; visualisations of a virtual universe, the reconstruction of destroyed buildings, and Agent-Based Models of social interaction in large populations. ARC also support interrogation of datasets from broader society, environment and culture including Social Media and the Digital Tech Community. ARC has also worked with external partners to deliver a number of joint projects, including:

- Project SWITCH, working with Proctor & Gamble and IBM to look at customer conversion behaviour
- Digital Catapult Centre – working with SMEs to accelerate products to market.

ARC's clients include a mixture of both SMEs and global blue chip companies, with Durham University able to support a wide range of industry partners in a wide range of sectors and locations. ARC funding is a mix of Government funding, via Research Councils and Innovate UK, and industry partner contributions.

Science and innovation asset – automotive manufacturing: Zero Carbon Future

Zero Carbon Future are consulting engineers and project managers that deliver activities to support the transition mainly to electric vehicles. Their main activities are:

- CPD training
- Skills training
- Consultancy
- Project management.

Zero Carbon Future's services are used by a wide variety of organisations including:

- Governments
- Local authorities
- Automotive manufacturers (including BMW, Nissan, Renault, VW, Porsche and Morgan).
- Energy companies (including EDF and Ecotricity)
- Businesses in other sectors
- Individuals.

Partners include BEIS, DfT, APC, KTN and IET. Services are funded through a mix of grants and commercial contracts. In 2011, as part of a Gateshead College bid, a capital grant of £6.2 million was secured from the Regional Growth Fund (RGF). Zero Carbon Future have identified their key success as have survived, grown and to have become internationally recognised in their field. This reflects their knowledge and experience of practical project delivery, which has led to their credibility within a market that is dominated by major multinationals (e.g. Arup, AECOM, Arcadis, CENEX, etc.)

Science and innovation asset – automotive manufacturing; Centre of Excellence in Sustainable Advanced Manufacturing (CESAM)

The University of Sunderland, the North East Automotive Alliance and other local partners are developing a £54.5m Centre of Excellence in Sustainable Advanced Manufacturing (CESAM). This will enhance adoption of innovation, skills development and process improvements for advanced manufacturing companies in the North East. This will be provided through full-scale demonstration production lines which will complement other investment such as the International Advanced Manufacturing Park (IAMP) and wider sector development activities. By enabling shared facilities and expertise to flow between companies and through the supply chain the full value of process productivity improvements can be achieved enabling greater financial competiveness and innovation stimulation. CESAM would also be able to operate as a route to train company staff and disseminate knowledge and expertise and provide awareness and progress potential of engineering as a career. This facility to test and demonstrate at scale the productivity improvements is required due to the cost and disruption of changes to manufacturing lines which places a premium on ensuring that changes are correct before undertaken across a site. Constant improvements to these are required to stay competitive, utilise new approaches and technologies and respond to consumer demand.

Science and innovation asset – automotive manufacturing: Automotive and Manufacturing Advanced Practice Centre

The Automotive and Manufacturing Advanced Practice Centre (AMAP) is part of the Faculty of Engineering and Advanced Manufacturing at the University of Sunderland. The vision for AMAP is: "to inform, inspire and innovate in Advanced manufacturing, which we will achieve by being an innovative, accessible, and outward facing provider of support for industry. This will based upon the application of research and knowledge of advanced manufacturing regionally, nationally and internationally - adding unique value and excellence to differentiate and enhance the student experience, the Faculty of Engineering & Advanced Manufacturing and the University. The centre works with academics and businesses in the automotive sector to undertake research and development where it is fundamental to business growth with a focus on design and manufacturing processes rather than just product design. This process can be gradual and incremental through continuous improvements as well as disruptive change.

Science and innovation asset – automotive manufacturing: Gateshead College – Skills Academy for Sustainable Manufacturing and Innovation (SASMI)

SASMI at Gateshead College is a world class centre to train workers for green industry in the North East. The sustainable centre, based at Nissan's Washington plant, is preparing the region's workforce in the skills they need to work in the low carbon industries of the future. SAMSI provides:

- A training infrastructure for sustainable manufacturing and the low carbon vehicle industry
- A world class learning facility for employers, apprentices and students, providing new skills for new jobs
- Access a full range of skills and training provision for companies from across the region
- Best practice delivery from Nissan and the automotive sector.
- Individuals with training opportunities in the 'green collar' economy, harnessing the expertise in this field that Gateshead College has already established.

Gateshead College is also home to the Skills Academy for Automotive Engineering, Manufacturing and Logistics. Based at Team Valley, the Skills Academy has a wide-variety of equipment including; state-of-the-art driving simulators, MOT testing equipment, a rolling road, specialist diagnostic equipment, spray booths and a dedicated welding workshop.

Science and innovation asset – chemical manufacturing: North East Process Industry Cluster (NEPIC)

NEPIC is an award winning membership organisation working with the chemical-using industries in the North East of England. It covers a broad range of chemistry focused industries including petrochemicals, polymers and materials, fine and speciality chemicals, pharmaceuticals, biotechnology and renewables. As a privately-owned, industry-led partnership, NEPIC has works with its membership to help these become successful and sustainable organisations as required by business. To assist with industry attraction and growth, NEPIC supports companies in securing their major capital projects, management buyouts (MBO) and start-ups. The Cluster provides intelligence on local supply chain capabilities in areas such as site location, planning, infrastructure, raw material sourcing, engineering, logistics, measurement science, workforce development and legal advice. In addition to individual support, NEPIC provides a more collaborative environment the cluster has created a more compelling interactive and proactive business community, which is a more attractive environment for investors; and helped raise the international profile resulting in a strong investment portfolio of 62 projects totalling £6.5bn. The Cluster's activities and interactions include: investment growth; skills & education; innovation; communications & marketing; supply chain development; improved connectivity; SME participation growth & increased international awareness. In March 2014, NEPIC became the first UK cluster - and one of only 36 in Europe - to receive Gold Label Accreditation for Cluster Excellence via ESCA.

Science and innovation asset – chemical manufacturing: Materials Processing Institute

The Redcar based Materials Processing Institute is a research and innovation centre, with a seventy year track record in the development and upscaling of technologies for the materials, processing and energy sectors. This includes accelerating SME growth through its SME Technology Centre and co-ordinating university interaction through its Doctoral Academy. The Institute is internationally renowned for its expertise in challenging processes, particularly those involving high temperatures, hostile environments and high specification materials. Many processing technologies that are the global industry standard for these sectors were developed at the Institute. The Institute offers expertise, physical capabilities and physical assets for customers and collaborators to explore and develop new material and processes improve existing products and processes and realise lasting improvements in energy efficiency and process reliability, whilst reducing the environmental impact of their processes. The Institute is based in purpose-build laboratories with facilities over a range of scales from fundamental laboratory scale experiments through to the construction and operation of demonstration scale pilot plants. Specific activities and capabilities are structured around:

- Provision of process support
- Material and metals industry consultancy
- Pilot and demonstration facilities
- Iron and steelmaking process technology
- Supporting science
- Specialist melting
- SEM Technology Centre
- Post-doctoral academy

Science and innovation asset – chemical manufacturing: TWI

Established in 1946, TWI employs over 800 people including respected consultants, scientists and engineers to work with over 1800 industrial member companies across 70 countries. TWI is one of the world's foremost independent research and technology organisations, with expertise in materials, joining, structural integrity and engineering processes as applied across a range of industries including chemical and processing. Headquartered in Cambridge, with technology centres in Teesside, Yorkshire and Port Talbot, TWI specialises in innovation, knowledge transfer and solving problems across all aspects of manufacturing, fabrication and whole-life integrity management. The Middlesbrough Technology and Training Centre was set up in 1992 as an extension of the Cambridge headquarters and complements TWI's work in engineering consultancy and industry training. Its most recent premises were opened in 2016 by the Rt Hon the Lord Heseltine CH providing a £10m purpose-built facility drawing on European Regional Development and Regional Growth funding along with investment from TWI. Research and development work covers a wide range of technologies for industry sectors including oil and gas, chemical, power and transport. Services include materials characterisation and modelling for safety critical applications on structures and welds, surface and coatings technologies, fitness-for-service assessments and additive manufacturing simulation support. The Centre's training and examinations facilities contain specially designed training suites and state-of-the-art equipment for underwater inspection, plastics joining, weld inspection and non-destructive testing applications. Training delivered on site enables engineers to use the latest technologies to ensure the safety of structures such as offshore platforms, wind towers, chemical plant and oil pipelines.

Science and innovation asset – pharmaceutical manufacturing: First for Pharma

Established in 2011 to act as a gateway into the North East pharmaceutical sector, First for Pharma brings together representatives of some of the world's largest pharmaceutical and biologics manufacturing companies alongside smaller organisations in the fields of manufacturing, medical devices, assistive technology and health informatics to support the regional pharmaceutical manufacturing ecosystem. As a network First for Pharma aims to represent this this large and important sector and to coordinate strategy and identify success in the cluster; to articulate sector needs and to act as a voice for the sector. First for Pharma enables networks and linkages to be made between the 13 large pharmaceutical manufacturing sites in the North East, employing 2,600 people. They generate one third of the UK's pharmaceutical manufacturing GDP and 95% of their high-value products are exported globally. The value of pharmaceutical exports (over £2bn) is the highest in the UK per capita and is only marginally less than that of the North East's automotive sector. It also works with the supply chain and linked companies to support innovation and sector-wide engagement. To achieve these aims, First for Pharma hosts discussion dinners for senior sector managers four times annually. It has recently completed an economic audit of the contribution that the sector makes to GVA and exports. The report, compiled in collaboration with the North East Local Enterprise Partnership and the Centre for Process Innovation, has figured in the Office for Life Sciences Life Sciences Industrial Strategy.

Science and innovation asset – pharmaceutical manufacturing: Centre for Process Innovation (CPI)

The Centre for Process Innovation (CPI) is a UK based technology innovation centre and the process centre for the High Value Manufacturing Catapult. Established to support the UK process manufacturing industry, CPI collaborates with universities, SMEs and large corporates to help overcome innovation challenges and develop next generation products and processes. Operating across a broad range of technologies, CPI supports its partners at every step of the way; from concept to market; business support to technology development; from scale up to supply chain intervention. CPI supports a sector which currently exports almost £50bn a year with a contribution of over £15bn a year to the UK's Gross Domestic Product. CPI leverages its assets, providing significant return on investment which nurtures and supports innovation in this sector. CPI currently leads on facilities and projects including the National Biologics Manufacturing Centre in Darlington and centres for Graphene Applications, Formulation and Printable Electronics in Sedgefield. Looking forward, a new national centre of health care photonics at NetPark will focus on new light based therapies and CPI and the North East LEP are working together to develop a new initiative around the smart delivery of medicines focused on packaging and the digital delivery of medicines.

Science and innovation asset – pharmaceutical manufacturing: Newcastle Laboratory

Newcastle Laboratory is one of 20 building plots that form the 24 acre Newcastle Science Central site. Other assets located on the Science Central site include the National Innovation Centre for Ageing and National Innovation Centre for Data. Opening in late 2018, Newcastle Laboratory will provide over 70,000 sq.ft. of supported specialist facilities for the life sciences and healthcare sector. A unique eco-system of associated services will also be provided through a bespoke business acceleration service, including ready access to expert advice and industry knowledge to help tenants innovate and grow, and to use insight-led research to support the commercialisation of products and services. The state-of-the-art building has been developed by a design team led by Aura alongside award-winning architects Ryder, who have been supported by leading industry specialists including CAM-SCI, to ensure the building meets the needs of the healthcare and life sciences sector.

Science and innovation asset – pharmaceutical manufacturing: Academic Health Science Network Innovation Pathway

The Academic Health Science Network North East and North Cumbria (AHSN NENC) created the Innovation Pathway to broker engagement between NHS organisations and industry to bring good ideas to life and create wealth across the region.

Through engagement with NHS colleagues, academics, other healthcare professionals and industry, innovative concepts are identified and supported to achieve success and promote economic growth.

The Innovation Pathway, delivered by the AHSN and its partners facilitates bespoke services across the entire lifecycle of innovation to both NHS organisations and industry to help turn ideas into reality and to achieve commercial success and benefit patient care

Example of wider ecosystem: Innovation SuperNetwork

The Innovation SuperNetwork is a unique regional programme, helping to cultivate a stronger innovation eco-system in the North East of England and support innovative businesses. The programme works through a partnership of around 50 organisations, including the North East LEP, Innovate UK, North East BIC, Northumbrian Water, Reece Innovation, Engie, local universities and colleges, innovation support organisations and private businesses. The SuperNetwork is part-funded through the European Regional Development Fund (ERDF) and the North East LEP.

The SuperNetwork includes:

- High profile events to raise aspiration and innovation expertise amongst regional businesses including masterclasses and a programme of events;
    - An active access to finance programme to connect regional businesses with investors and increased awareness of and access to funding and finance (such as VentureFest and Finance Camp);
    - Coordination work to link up businesses with sources of expertise and support;
    - An open innovation programme, connecting regional businesses with innovation challenges posed by larger businesses and the public sector.

The programme expanded in 2018 to include support delivered through cluster organisations and business groups, ensuring that innovation support is available to a much wider range of businesses than can currently access it. In addition, we are working closely with partners on increasing the level of support available in the region for open and collaborative innovation projects.

Example of wider ecosystem: Northern Accelerator

The Northern Accelerator project was established in September 2017 as collaboration between Durham and Newcastle universities, with the project building upon this so that Durham, Newcastle, Northumbria and Sunderland universities are working together to make a step change in delivering research to the market. The accelerator will develop entrepreneurship amongst academics through an ideas impact hub and associated proof of concept support as well as work with start-up companies and spinouts.

The project will focus on four areas of regional strength – advanced manufacturing, chemicals and process sector, life sciences and healthcare and digital. The project will support the ambitions for high skills job growth in these sectors as identified by the Strategic Economic Plans of both the North East Local Enterprise Partnership and Tees Valley Combined Authority.

Durham University is the lead institution on the Northern Accelerator project, which is chaired by a strategic advisory board made up of leading figures from academia and business including:

- BEIS Advisory Group for Science & Innovation Audits
- Northumbrian Water
- North East LEP Board
- Tees Valley Combined Authority.

The Northern Accelerator has received funding of £4.9 million from the Connecting Capability Fund and plans to expand over the next 3 to 5 years.

Example of wider ecosystem: NETPark – the North East Technology Park

Located at Sedgefield, County Durham, NETPark is an internationally recognised location for science and technology companies. NETPark hosts the national innovation centres lead by the Centre for Process Innovation including:

- National Printable Electronics Centre
- National Formulation Centre
- National Centre for Healthcare Photonics
- High Value Manufacturing Catapult Centre.

These centres promote business-led collaboration between scientists and engineers to exploit market opportunities. NETPark encourages collaborative multidisciplinary links and focuses on supporting companies that are integrating materials into high value innovative products, particularly printable electronics, microelectronics, photonics and nanotechnology, and their application in the fields of energy, defence, and medical-related technologies.

NETPark also offers a range of offices and laboratories and hosts a number of innovative businesses. By providing an exceptional environment, a talented workforce and a local readymade manufacturing supply chain. Netpark provides companies with access to a focused and international community where talent flourishes, ideas are generated and businesses have the support and resources to compete with the best in the world.

NETPark Explorer is a new £7.6m development at NETPark that will offering companies graduating from the NETPark Incubator or looking to locate in the region access to a laboratory, clean room and office space of between 3,500 and 5,000 sq.ft.

Appendix 5: Enterprise Zone sites

Queens Meadow Business Park, Hartlepool (13.6 hectares) Located close to Hartlepool Port Estates and ABLE Seaton Port, this site expands on the existing business park with offices and industrial units.

Teesside Advanced Manufacturing Park (TAMP), Middlesbrough (11 hectares) Located next to the highly successful Riverside Park Industrial Estate, TAMP offers the opportunity to be part of an already established cluster of manufacturing businesses.

Kirkleatham Business Park, Redcar & Cleveland (12.6 hectares) The site has serviced land ready for development as well as existing office and industrial buildings available for immediate occupation, it neighbours the integrated chemical site Wilton International.

Belasis Business Park, Stockton-On-Tees (8.5 hectares) An established business park with existing office units this site is perfect for companies in any sector looking to move or expand into the area. It is located close to Offshore Structures (Britain) and Wilton Engineering.

Oakesway Industrial Estate, Hartlepool (12.7 hectares) Part of an existing industrial estate, the Oakesway Enterprise Zone site is situated close to Hartlepool Port Estates.

Northshore, Stockton-On-Tees (6 hectares) The site is located in close proximity to Stockton town centre and forms part of the mixed use regeneration of the riverside. The creation of a vibrant business quarter is built around the digital, advanced manufacturing, science and technology sectors.

Central Park, Darlington (8.4 hectares) Central Park is already home to the national Biologics Manufacturing Centre which helps companies of all sizes in the biologics market to develop, prove, demonstrate, scale up and ultimately commercialise new biologics process technologies.

Historic Quarter, Middlesbrough (9.5 hectares) Situated next to the thriving digital cluster of Boho, the site is located close to the town centre of Middlesbrough, near both Teesside University and Middlesbrough College.

Hartlepool Port Estates, Hartlepool (56.9 hectares) Part of the existing operating port in Hartlepool with five fully serviced quays, a total length of 900m across three berths.

New Energy & Technology Park, Stockton-On-Tees (41.3 hectares) Part of the Seal Sands energy and chemicals hub the site was recently cleared and levelled. It has B2 planning designation permitting land to be developed for potentially high hazard plant and energy generation.

Wilton International, Redcar & Cleveland (164 hectares) Five development plots are available at Wilton International. The fully serviced chemical complex has existing infrastructure including power, steam and water giving companies the opportunity to 'plug and play'. The site is also close to Wilton Centre R&D facility and has pipe linkages to the north of the River Tees, which also offers jetties and storage facilities.

Blyth Estuary, Blyth (16.48ha) Across the four sites (East Sleekburn, Bates and Wimbourne Quay, Commissioner's Quay and Dun Cow Quay) The Blyth Estuary Enterprise Zone builds on the presence of the Offshore Renewable Energy Catapult in Blyth with a focus on supporting businesses linked to offshore energy and marine engineering. The site is well served by a strong local supply chain and training provision.

North Bank of the Tyne, Newcastle (66ha) across three sites The North Bank of the Tyne sites support the wider CORE (Centre for Offshore Wind and Renewable Engineering) status to focus on businesses which operate in these areas and/or benefit from close proximity to the Port of Tyne and river front location. The three sites (Neptune, Swan Hunter and Port of Tyne provide access to riverfront sites and an established supply chain of businesses and skills.

A19 Corridor, Washington, (32.53ha) across 3 sites Located in close proximity to a global automotive supply chain and skills expertise in AMAP (Institute for Automotive and Manufacturing Advanced Practice) and SASMI (Skills Academy for Sustainable Manufacturing and Innovation) the A19 corridor sites focus on low carbon vehicles and advanced manufacturing. The three sites are clustered close to main road transport connections to the A19 and access to the A1 and ports.

Ramparts Business Park, Berwick (6.6ha) Expanding on the existing Ramparts Business Park the site will improve the provision of business premises in Berwick. This will particularly focus on improving the quality of manufacturing and industrial premises building on these existing economic strengths in Berwick. The site is well located mid-way between Newcastle and Edinburgh close to the A1 and Berwick railway station.

Fairmoor, Morpeth (9.23ha) Fairmoor is a greenfield development site linked to wider economic development in northern Morpeth. The site will benefit from additional road investment to further open up the site which is already well located on a junction for the A1. The site is intended to support knowledge intensive growth drawing on the high-skilled population of Morpeth and the surrounding area by developing an innovation park with new office, light industrial and incubator premises.

Ashwood Business Park, Ashington (16.13ha) Capitalising on the success of Ashwood in attracting major pharmaceutical and manufacturing firms to the area, Ashwood Enterprise Zone site is a large location focused on pharmaceuticals and mixed manufacturing linked to the strengths shown in the local economy. The site already boasts high-profile and international businesses located on north-south road connections and planned improvements to east-west connectivity.

Newcastle International Airport Business Park, Newcastle (41.7ha) This multi-phased site will provide significant new capacity next to the growing Newcastle International Airport. The initial phase of development will provide high quality office space targeted at businesses which will benefit from the proximity to national and international connectivity provided by the airport and more locally through the metro system and A1. Further sites will similarly support business growth with a premium on connectivity including logistics and warehousing.

North Bank of the Tyne extension, Newcastle (2.79ha) This extension to the existing successful Enterprise Zone along the north bank of the River Tyne will continue to support additional businesses with a focus on maritime engineering, oil and gas. Located on the former Swan Hunter and Neptune shipping yards the existing sites support key sectors, this will provide more opportunity for further growth, including larger units.

Holborn Riverside, South Shields (11.62ha) This development at the mouth of the River Tyne comprises two distinct sites playing complementary roles making the most of the riverfront location. The first site will provide larger floorplate Grade A office development which will address a local gap. The second site will complement the long-standing marine expertise in the area by providing new enhance high-quality manufacturing space with a focus on offshore energy and marine sectors making the most of the 580m river front and quays.

Follingsby Business Park, Gateshead (28ha) Well sited on the A19, the Enterprise Zone site builds on the existing Follingsby site, significantly increasing the site available. The site links closely to wider activities on the A19 corridor and will provide logistics, distribution and industrial space. It will support particular growth in distribution and logistics due to location along main transport corridors.

International Advanced Manufacturing Park (IAMP) (25ha) As part of the nationally significant International Advanced Manufacturing Park development this site will bring forward major industrial and manufacturing space and facilities. This will specifically support development of businesses operating in the low carbon and automotive/passenger vehicle areas as well as wider potential for logistics, energy and offshore manufacturing linked to local economic strengths.

Port of Sunderland, Sunderland (8.3ha) The Port of Sunderland has ambitious growth plans to make the most of its location at the mouth of the River Wear and direct access to the North Sea as well as integrated modal shift with a reinstated rail head and strong road connectivity. The site development will focus on manufacturing, storage and distribution particularly for offshore energy, marine industries such as cabling and export focused sectors which make the most of the location of the port.

Jade Business Park, Murton (26ha) Jade Business Park is a ready for development site located close to the A19. The site will focus on linkages to local clusters of automotive, high-value engineering and low carbon energy and technologies businesses providing an opportunity for large-plate developments.

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