

Applied digital technologies in advanced manufacturing

Science and Innovation Audit Summary Report



Science and Innovation Audit partners:



Introduction

The focus of this Science and Innovation Audit (SIA) is the application of digital technologies in advanced manufacturing in the North East of England.

The North East has a population of 2.6 million individuals¹ and over 74,000 businesses². In 2016, the region produced £50.7 billion of goods and services³. The region includes a mix of cities (Newcastle, Sunderland and Middlesbrough), urban and rural areas, with economic activities concentrated around the coastline and rivers.

The chosen theme of the SIA reflects the importance of manufacturing to the North East economy and the opportunities that our region's growing digital sector provides to support the manufacturing sector to adopt digital technologies. This has potential to lead to future co-creation between the sectors to develop new products and services.

The approach of the Science and Innovation Audit is closely linked to the concept of Industry 4.0. Based on the original proposition set out by the German Government⁴, 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, individualised and digitally enabled products. The focus of Industry 4.0 is on advanced manufacturing on process improvements to help businesses become more productive and deliver new products.



1 Data from Population estimates – local authority based by single year of age (Nomis). Data for 2016.

2 Data from UK Business Counts (Nomis). Data for 2017.

3 Data from Regional Gross Value Added (balanced approach) (ONS). Data for 2016.

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

Manufacturing plays a key role within the North East economy, accounting for 14.3% of the region's GVA⁵ and 10.6% of employment⁶. In 2017, the North East exported £12.9 billion worth, including goods valuing £7.4bn of machinery and transport and £2.8bn of chemicals (including pharmaceuticals).⁷ The North East's manufacturing firms are concentrated in a number of specialist, high value advanced manufacturing sectors. The SIA has focused on three of these:

- Automotive manufacturing
- Chemicals manufacturing (including bulk and specialty chemicals, polymers and plastics, and materials)
- Pharmaceutical manufacturing.

The Government Office for Science (2017)⁸ identified a range of technologies – including batteries; algorithms and machine learning; quantum security of the Internet; and robotics and autonomous systems – that are generating (individually and in combination) opportunities to create applications for businesses, governments and individuals. These digital technologies sense, detect and measure what is happening and use the data this generates to produce insights and drive changes. These technologies have real potential to improve productivity within the North East's advanced manufacturing businesses with key opportunities including:

- Connected factories
- Connected supply chains
- Virtual reality and augmented reality.

The approach set out in this SIA draws on the importance of proximity to support the successful integration of new technologies. Whilst digital businesses are able to transcend geographic boundaries, there is also evidence that proximity to clients can increase opportunities for innovation. In particular, where there is a requirement to share commercially sensitive information around challenges or opportunities a level of trust, often through previous work or knowledge is advantageous. This does not mean that proximity is always required or sufficient alone but that in these circumstances it makes a positive contribution.

The key partners involved in the SIA are North East Local Enterprise Partnership (LEP), Tees Valley Combined Authority, Digital Catapult North East and Tees Valley, CPI, Zero Carbon Futures, Sunderland Software City, High Value Manufacturing Catapult, North East Automotive Alliance, First for Pharma, Durham University (on behalf of the North East's five universities) and the North East England Chamber of Commerce. Through the industry bodies, key private sectors companies have been engaged in and informed the process.

Vision

The vision for the SIA is: To deploy the North East's potential to be at the forefront of the next manufacturing revolution by enhancing the routes to develop and integrate digital technologies into manufacturing process improvements. Through this we will position the North East as the ideal place to articulate, develop and adopt digital approaches to manufacturing to support long-term UK export competitiveness in high-value, advanced manufactured goods particularly focused on automotive, chemical and pharmaceutical sectors.

Key strengths

As outlined earlier, the North East has specialisms in a number of manufacturing industries - automotive, chemicals and pharmaceutical. A selection of key businesses within these three industries is given below.

Automotive manufacturing	Chemicals manufacturing	Pharmaceutical manufacturing
Nissan Komatsu	AkzoNobel Performance Coatings	Accord Healthcare
Caterpillar		Aesica Pharmaceuticals
Cummins	Applied Graphene Materials	Arcinova
Calsonic Kansei		Biosignatures
Gestamp-Tallent	Banner Chemicals	Fujifilm
Unipres	Biffa Polymers	Diosynth Biotechnologies,
Vantec Europe	CF Fertilisers	GlaxoSmithKline
ZF-TRW R-Tek	Chemoxy International Ltd	Glythera
BorgWarner	Conoco Philips	High Force Research
AVID technology	Dupont Teijin Films	MSD
Hyperdrive	Exwold Technologies	Orla Protein Technologies
	Fine Organics	Piramal Healthcare
	Greenery International Ltd	Sterling Pharma Solutions
	High Force Research	Wasdell
	Huntsman Chemicals	Merck Sharp & Dohme Limited
	INEOS	
	Johnson Matthey	
	Kilfroast	
	Lotte Chemical UK	
	Lucite International	
	Micropore	
	Procter and Gamble	
	Plaxica	
	SABIC Petrochemicals	
	Thomas Swan	
	Tracerco	
	Victrex	

Source: Compiled by SIA consortium members

5 Data from Regional Gross Value Added (balanced approach) (ONS). Data for 2016.

6 Data from Business Register and Employment Survey (Nomis). Data for 2016.

7 Data from HMRC Regional Trade Statistics (HMRC). Data for 2017.

8 Government Office for Science (2017) Technology and Innovation Futures 2017.

The sector is supported by a strong science and innovation base.

- The automotive manufacturing industry in the region is supported by the North East Automotive Alliance (NEAA), the largest automotive network in the UK. The International Advanced Manufacturing Park (IAMP) will offer a high quality, integrated location for advanced manufacturing, with a strong focus on automotive manufacturing adjacent to existing manufacturers. Other assets in the region include, the High Value Manufacturing Catapult, the Automotive and Manufacturing Advanced Practice Centre at the University of Sunderland and Zero Carbon Futures and the planned Centre for Sustainable Advanced Manufacturing.
- The chemicals manufacturing industry is supported by the North East Process Industry Cluster (NEPIC), an award winning membership organisation. Key assets in the region include the Materials Processing Institute, TWI and the Technology Futures Institute and the Centre for Process (CPI) Innovation Graphene Application Centre. The assets and opportunities for the broader chemicals industry is more fully set out in the chemicals and processing SIA.
- The pharmaceutical manufacturing industry is supported by First for Pharma, which brings together some of the world's largest pharmaceutical and biologics manufacturing companies alongside smaller companies to support the development of a regional pharmaceutical manufacturing ecosystem. The sector is supported by the CPI National Biologics Manufacturing, CPI National Formulation Centre and the Newcastle Laboratory. The region also has a number of wider life science assets (including the Academic Health Science Network North East and Cumbria, National Innovation Centre for Ageing, Centre for Ageing and Vitality and Centre for Life). These are important to the pharmaceutical manufacturing industry, with the North East being one of the few locations that can provide an end-to-end translation environment ('bench to bedside').

Looking at the design, development and application of digital technologies, the region's key assets include:

- The Digital Catapult Centre North East and Tees Valley, led by Sunderland Software City, delivers interventions to grow the region's digital economy.
- The National Innovation Centre for Data has been established to help improve organisations' utilisation of data through a programme of collaborative projects. It received an investment of £15 million from Government in 2017, which has been matched by Newcastle University.
- Advanced Research Computing at Durham University brings together researchers from different disciplines to undertake transformative research, focused on (but not limited to) High Performance Computing (HPC). Advanced Research Computing has been awarded status as an Intel Parallel Computing Centre and an NVIDIA CUDA research centre.
- The region has a vibrant range of networks that support the digital sector (including Digital City, Digital Union, Dynamo, Sunderland Software City and Thinking Digital) and a number of start-up and co-working spaces (including BOHO, Immersion Labs, Sunderland Fab Lab and VRTGO Labs/Proto Lab). Other assets include Stellium, the Urban Observatory and the HMRC Digital Delivery Centre.

The importance of advanced manufacturing and the application of digital technologies have been identified by both the North East LEP and the Tees Valley Combined Authority and are prioritised within their strategic documents. This strategic commitment provides a strong basis for action in the region.

Strategic focus on advanced manufacturing and digital in the North East

North East LEP	Tees Valley Combined Authority
<p>Areas of opportunity</p> <ul style="list-style-type: none"> • 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 <p>Enabling services</p> <ul style="list-style-type: none"> • Financial, professional and business services • Transport and logistics • Education 	<p>Innovation Strategy key growth sectors</p> <ul style="list-style-type: none"> • Advanced manufacturing • Process and energy • Healthcare • Digital <p>SEP cross cutting theme</p> <ul style="list-style-type: none"> • Circular Economy

Growth opportunities

Automotive manufacturing

The key drivers of this market are:

- Demand for more connected supply chains, with potential impacts on costs, speed and reliability⁹.
- Requirement amongst automobile original equipment manufacturers (OEMs) to future-proof manufacturing processes¹⁰.
- Rapid expansion in global connectivity, including cloud computing, big data and analytics and smart sensors¹¹.
- Changing consumer markets and government regulation, with electric and autonomous cars being developed in response to changing demand and legislation¹².
- Increasing labour costs, leading to increasing interest in the use of robotics and other machinery¹³.

In terms of the size of this market:

- The market for automotive robotics was estimated to be worth \$5.07 billion in 2016 and forecast to grow to \$8.44 billion by 2021¹⁴.
- The market for connected cars is forecast to grow dramatically from its current value of \$30 billion to \$170 billion in 2020¹⁵.
- The automotive industry's revenue from Internet of Things- related activity is forecast to be \$23.6 billion by 2025¹⁶.
- The gains to the UK automotive industry from digitisation are estimated to be £6.9 billion per year by 2035, with this increasing GVA by £8.3 billion per year¹⁷.

The UK is not currently seen as a leader in digitisation of automotive manufacturing – but is thought to have the factors in place that would allow the market to develop rapidly¹⁸. Within the UK, the Nissan plant in Sunderland is seen as a good example of the adoption of digital technologies¹⁹.

Chemicals manufacturing

The key drivers of this market are:

- Mitigating supply chain risks, with Internet of Things technologies seen as offering opportunities (e.g. to track logistics, monitor changes in temperature and humidity, etc.)²⁰.
- More efficient management of data, with potential for this to generate valuable insights²¹.
- Safety management, with technologies enabling greater control of manufacturing and delivery processes and the development of alternative processes (e.g. use of drones for safety checks)²².

- Growing international competition²³.

A number of estimates have been made about the potential size of this market including:

- The materials handling robotics market is forecast to be worth more than \$3.4 billion by 2019, with a subsequent annual growth rate of 9%²⁴.
- The Internet of Things chemicals market was valued at \$3 billion in 2016, with this forecast to increase to \$4.7 billion by 2025²⁵.
- The chemicals software market is forecast to grow at an annual rate of 11% between 2018 and 2022²⁶.

Currently there is no evidence on the UK or North East's share of the global market in digitisation for the chemicals manufacturing industry.

Pharmaceutical manufacturing

The key drivers of this market are:

- Tackling counterfeiting, with digital technologies providing opportunities to reduce counterfeiting in both the supply chain and in end-use products²⁷.
- Product traceability, with growing complexity in supply chains and greater data collection making this more important²⁸.
- Increase in use of individualised medicines, with intelligent machines, the Internet of Things and data analytics being critical to ensuring robustness and stability of these smaller batches²⁹.
- Increased regulation, with businesses increasingly being asked to provide continuous product monitoring³⁰.
- Recognition of efficiency gains that can be secured from digitisation³¹. Significant growth is forecast for this market:
- The market for Internet of Things software and services in the pharmaceutical industry was valued at \$420 million in 2015 and is forecast to grow to \$2.5 billion by 2020³².
- The market for pharmaceutical robots was valued at \$130 million in 2016 and is expected to grow to \$430 million by 2025³³.
- The market for data analytics for the pharmaceutical industry is forecast to grow by 15% per annum between 2016 and 2021 (from a value of \$1.3 billion in 2016)³⁴.

Similar to chemicals manufacturing, there is no evidence on the UK or North East's share of the global market in digitisation for the pharmaceutical manufacturing industry.

9 World Economic Forum (date unknown) Building a digital automotive industry.

10 Berger, R. (date unknown) The Car Factory of Tomorrow is Digital.

11 World Economic Forum and Accenture (2016) Digital Transformation of Industries: Automotive Industry.

12 ARC Advisory Group (2017) Mercedes Moves to Smart Manufacturing.

13 KPMG (2017) The Digitalisation of the UK Automotive Industry.

14 Global Newswire (23 January 2018) Global Automotive Robotics market 2017-2021: \$8.44

Billion Industrie 4.0 And Made in China 2025 Industrial Plan Opportunities.

15 Grant Thornton (2017) India's Readiness for Industry 4.0: A Focus on Automotive Sector.

16 Statista (2018) Internet of Things: Automotive Segment Revenue Worldwide in 2014 and 2024.

17 KPMG (2017) The Digitalisation of the UK Automotive Industry

18 Grant Thornton (2017) India's Readiness for Industry 4.0: A Focus on Automotive Sector.

19 Ibid

20 EY (2016) Chemicals in Europe – the way forward – balancing the equation with customized innovation and strategy.

21 Deloitte (2016) Industry 4.0 and the chemicals industry: Catalysing transformation through operations improvement and business growth.

22 ARC Insights (2017) Industrie 4.0 in the Chemicals Industry; and Deloitte (2016) Industry 4.0 and the chemicals industry: Catalysing transformation through operations improvement and business growth.

23 ARC Insights (2017) Industrie 4.0 in the Chemicals Industry.

24 Modern Materials Handling (30 March 2016) Global material handling robotics market to exceed \$20 billion by 2019.

25 GME (7 January 2018) Internet of Things in Chemicals Market Size, Share, Analysis – Forecasts to 2025.

26 Research and Markets (2018) Global Chemical Software Market 2018-2022.

27 Medical Futurist (date unknown) What the Hell is Blockchain and What Does it Mean for Healthcare And Pharma?

28 Veeva (data unknown) Pharma 4.0 – time to rethink manufacturing and quality; and Pharma-ceutical Manufacturing (2016) Creating Value from Smart Manufacturing.

29 Veeva (data unknown) Pharma 4.0 – time to rethink manufacturing and quality.

30 PharmOut (date unknown) Pharma 4.0 – How Industry 4.0 Impacts on Pharma.

31 Markanian, J. (2016) The Internet of Things for Pharmaceutical Manufacturing.

32 GlobalData (20 March 2018) IoT software and services in the pharmaceutical sector will be worth \$2.4 billion by 2020.

33 Grand View Research (2017) Pharmaceutical Robots Market Size Share Industry Report.

34 PRNewsWire (10 October 2016) Commercial Pharmaceutical Analytics market to Provide Over USD 1.5 Billion Revenue Post 2016.

Gap analysis

The SIA has identified a range of assets in the North East in relation to both applied digital technologies and advanced manufacturing. Given the potential size of the market for applied digital technologies in advanced manufacturing, this gives the North East a strong opportunity to develop its digital sector whilst ensuring the ongoing competitiveness of its advanced manufacturing sectors.

There remains some uncertainty on the extent to which North East digital companies are currently working with advanced manufacturing companies in the region and vice-versa. It is clear however from engagement to date that there is scope for more intensive and structured support to enable solutions development and technical update of digital technologies in advanced manufacturing.

Key ambitions and proposals

Through the SIA process, the partnership has worked to develop a programme to accelerate the adoption of digital technologies within advanced manufacturing businesses in the region, including actions that will help overcome the barriers to uptake. The evidence base suggests that the digitisation of manufacturing is a major opportunity with potential implications for North East export competitiveness. The UK and more specifically the North East are well placed to take advantage of this opportunity. This is particularly true when applied to existing manufacturing strengths such as those in automotive, chemicals and pharmaceuticals. Despite this advantage the sectors are fast moving and there is a need to continually improve to stay ahead of competitors. Alongside increased competitions, changing market demand for complex and integrated products mean there is a need for manufacturers to make use of new technologies to remain competitive and the partnership's ambition is to facilitate this.

The process undertaken for the Science and Innovation Audit, including the gathering of data, consideration of global market trends and engagement of key partners have identified areas of opportunity and potential barriers to uptake that will benefit from additional focus, particularly 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 their advanced manufacturing and barriers to uptake.
- Raising awareness of the opportunities, potential and importance of the application of digital technologies for advanced manufacturing.
- Improving senior managers within advanced manufacturing businesses understanding 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 the Centre for Sustainable Advanced Manufacturing).
- Supporting cross-sector innovation sharing success and awareness so that other businesses are made aware of the potential benefits whether this is from a digital business perspective of engaging with manufacturers or vice-versa.

Business support and growth

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

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

Action plan

In considering how best to deliver these ambitions, a wide range of projects were considered. Potential funding routes for each project has 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 approaches undertaken underneath the ambitions 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 enhance existing regional strengths but together represent an effective, strategic and step change supported by a raft of wider initiatives and sector specific projects. The proposals will be integrated into the wider local ecosystem of business, and research required to be successful.

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

Through the CESAM project a new hub for the implementation of digital technologies into advanced manufacturing can be developed. From its initial development as a response to the needs of the automotive manufacturing sector, CESAM has the potential to expand to meet the needs of all of the advanced manufacturing sectors that have been examined in this SIA, providing a hub of expertise and test and demonstration facilities to trial and appraise technologies prior to roll out.

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

The gap in understanding of the opportunities and scope of digitalisation of the process industries and embedding this into the broader business support provided required a greater focus on these activities. This requires mentoring, 1-2-1 and seminar approaches alongside other supports to facilitate uptake and integration of the new technologies and approaches.

Digitalisation and digital manufacturing leadership and skills programme.

To develop a cross-sector network and structure to identify, refine and develop digital-led solutions for business requirements. This will be supported with further work with universities, schools, colleges and other skill providers to tailor programmes and short courses to meet skills demand. This will

include up- and re- skilling across different age groups to provide lifelong learning. A programme of leadership across businesses to embed and understanding of the potential and value of the application of digital technologies at the plant management level.

Improved networks for cross-sector solution development.

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 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 process to date opportunities have been around 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. A 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.

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.



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