Advanced Manufacturing & Engineering toolkit

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Introduction

The UK has a rich heritage in manufacturing and engineering. As the birthplace of the first industrial revolution over three hundred years ago, the tradition of innovation and creativity runs consistently throughout our history.

The Industrial Revolution saw Britain develop into the most technologically advanced country in the world. From Isambard Kingdom Brunel's railways, bridges and boats to Sir Frank Whittle's pioneering work in turbojet engine technology and from Michael Faraday's discoveries in electricity to John Smeaton – the father of civil engineering, the UK's history in this key sector reads like a roll call in icons of invention.

Manufacturing, however, is not just part of the UK's legacy. Over the years, the UK continues to play a vital role in the manufacturing and engineering development, being currently a global player, holding its own against manufacturing giants like the US and Germany. Additionally, the UK ranks **4th out of 131 economies** in the Global Innovation Index for innovation and research.

Home to **world-class companies in advanced manufacturing and engineering**, including Rolls-Royce, Arup, BAE Systems and Jaguar Land Rover, the UK benefits from a significant presence from international companies, such as Jacobs, Siemens, AECOM and Nissan.

Advanced manufacturing, which uses production processes that rely on cutting-edge science and technology, has been identified by the government as having high growth potential. The UK has **three of the world's top 10 universities in engineering and technology** and a strong research base, making it well placed to take advantage of drivers for growth.

The UK also benefits from a **mature venture capital market**, which helps support the growth of innovative businesses. In 2020, at least £8.8 billion was raised to grow such businesses – more than France and Germany combined . Through policies, such as Build Back Better, and its strategy to support Research and Development (R&D), the UK Government is committed to continuing investing in these areas.

The growth of and potential for 'green' products and services cannot be underestimated. Its importance is also reflected in government policy, with a commitment to being a world leader in 'clean growth'. The **Ten Point Plan for a Green Industrial Revolution** is at the heart of the 'Build Back Better' agenda.

The next Industrial Revolution, or **Industry 4.0**, will be driven by technologies including AI and robotics – developments that will shape the future of manufacturing and engineering. However, Industry 4.0 is not simply about investing in technology to improve manufacturing efficiency—it is about revolutionising how the entire manufacturing and engineering sector operates and grows.

In his recent UK Research and Development Roadmap, the Rt Hon Alok Sharma MP, Secretary of State for Business, Energy and Industrial Strategy, said that **public investment in R&D would reach £22 billion per year in 2024-2025**. The UK, he said, is 'the very best place in the world to be a researcher, inventor or innovator'.

A combination of world-leading universities, a commitment to green technology and government investment makes the UK not only well placed for growth, but also a sound proposition for investment.

Sector in Stats

- According to the World Economic Forum, by 2025, the fourth industrial revolution is expected to create a value of **£2.7 trillion** worldwide
- **23%** of the UK's total turnover is generated by the engineering sector, with manufacturing being the largest contributor to this[2]
- In 2021, the manufacturing sector accounted for **9.7%** of total UK economic output (GVA)
- In the last decade, UK manufacturing productivity grew **2.5x** faster than the overall economy
- The sector accounts for **7.3%** of jobs and employs **2.7 million** people across the UK[3]
- It accounts for 45% of total exports, totalling **£275 billion**, represents **69%** of business research and development (R&D) and provides **13%** of business investment[4]
- **18%** of the UK working population works in engineering, with at least **15%** of the working population in every region employed in engineering jobs[5]
- The Government's 10 Point Plan for the Green Industrial Revolution will mobilise **£12 billion** of government investment, along with potentially three times this amount from the private sector, to create and support up to **250,000** green jobs
- UK Electronics is the world's fifth-largest in terms of production - **14** of the world's top **20** semiconductor companies have established design and/or manufacturing sites in the UK
- The total UK RAS market is expected to grow at an annual rate of more than **40%** between 2020 and 2030, reaching an estimated market size of almost **£3.5 billion** by 2030[6]

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Sub-sectors

The advanced manufacturing and engineering sector encompass a diverse and extensive range of sub sectors:

Robotics

This fast-evolving sector, often referred to as RAS (robotics and autonomous systems), includes machinery and physical systems that can act and adapt within a given situation or environment independently of human control. RAS improves not only manufacturing but also other sectors, such as healthcare and transport. For instance, UK researchers have developed a low-cost radar technology that enables cars to drive themselves.

Designed to have a range of 6,000 meters, British autonomous submarines were the first to explore under a polar ice shelf.

The field has huge potential to bring about significant economic impacts, increasing productivity and helping free up workers for more 'high-value' tasks as well as improving resilience in challenging times. RAS has far-reaching potential applications across advanced manufacturing and engineering, and its development is complementary to advances in these sectors[7].

The UK growth opportunity is **£13 billion** in the global market for RAS by 2025[8].

Materials

The development of **high-tech materials** will play a critical role in the future success of many industries. High-tech materials are subset of products that require scientific and technical knowledge. Among the many examples of high-tech materials, there are the *metamaterials*, artificially structured composite materials; the *2D materials*, formed with only a single layer of atoms, which could be used in batteries, to strengthen existing materials or have new electrical applications; and the *'living materials'*, systems that can change the shape or self-repair and composite structures that can be more lightweight or durable than traditional technologies.

Such is the importance of the area that the government has included high-tech materials research and investment in its Innovation Strategy and, recently, called on evidence to help shape its policy. Additionally, the government is creating an **Advanced Materials Scoping group**, industry and academic leaders that will support the government assessing responses to the call for evidence.

Sensors Reality

Sensor and instrumentation technology are utilised across a wide range of industries and research areas and has a key enabling role. As well as having a practical use for monitoring various aspects of production, sensors help provide information that can improve **efficiency, quality and the process of production**. Given its importance to so many areas of manufacturing, industry and science, from medical technology to microelectronics to robotics, it is also an area with great growth potential.

It is estimated that **£120 billion** of the UK economy is underpinned by the sensor and instrumentation community[9] and that it contributes £14 billion a year to the UK economy, employing over 73,000 people working across small and medium-size enterprises as well as larger-scale organisations[10].

Electronics

With an estimated annual value of around **£19.4 billion** to the UK economy, the electronics manufacturing sector employs around 300,000 people in **over 12,000 companies** around the country and accounts for nearly 5% of total manufacturing output. The UK manufacturing industry in the third-highest investor in Research and Development, and it is expected to growth further.

Largely due to increased demand for electronic items during national and international lockdowns, the electronics sector has weathered the COVID storm well. Besides the everyday items, such as TVs, heating systems and fridges, the growth of **4IR technologies** and the **'Internet of Things'** will in turn generate increased demand for new electronics to support them. Due to such enormous reliance on electronic components, the global consumer electronics market is projected to surpass **$1,500 billion by 2024** – creating huge potential for UK electronics manufacturers[11].

[2] Sustainable infrastructure: the key to achieving energy transition, DIT (Nov 2021)

[3] UK Manufacturing PMI (June 2022)

[4] UK Manufacturing Statistics, The Manufacturer

[5] Mapping the UK's Engineering Workforce Engineering Council (Sept 2020)

[6] Economic impact of robotics and autonomous systems (RAS), BEIS (Nov 2021)

Sub-sectors

Photonics

[7]Economic impact of robotics and autonomous systems (RAS), BEIS (Nov 2021)

[8]RAS infographic, gov.uk

Described as 'the hidden economic engine', the UK photonics industry contributes nearly **£13 billion a year** to the UK economy and employs more people than pharmaceutical manufacturers.

Photonics technologies range from basic optical lenses and optical fibre to lasers, displays and cameras of all types. The leading photonic manufacturing clusters in the UK are located in Northern Ireland, Scotland, the Midlands and the South of England. The UK is also home to the **Electronics and Photonics Innovation Centre (EPIC)** – an £8 million centre with modern labs and technical capability to support R&D, design and new product development.

The field has far-reaching applications in some of the most innovative technology areas, including digital laser manufacturing, internet 5.0 and future data, non-invasive healthcare and remote vision. Currently, **growth rates** sit at around **5-9%**, but the sector has been earmarked as having huge growth potential[12].

Automotive and Aerospace Manufacturing

The UK is recognised internationally as a **world leader in automotive and aerospace manufacturing**. The UK automotive industry adds **£15.3 billion** to the UK economy annually, directly employing some 180,000 people in manufacturing.

The UK's aerospace industry is the second biggest in the world, only behind the US, employing around 120,000 people in highly-skilled jobs around the country. Whilst the UK does not produce large civil aircraft, it is a **centre of excellence for designing and producing engines, helicopters, wings and structures and aircraft systems. Catapults are located across the UK, developing sustainab**le innovation-driven solutions for the aerospace sector.

New related areas of development such as space technology, drones, sustainability and a focus on green technology are key areas for growth in both aerospace and automotive manufacturing.

[9]UK Sensor Community Mapping, Knowledge Transfer Network (KTN)

[10]Sensors and instrumentation, UKRI

[11]UK Electronics manufacturers: A healthy serving of Pi & chips, The Manufacturer (Nov 2020)

[12]UK Photonics: The Hidden Economy (May 2018)

Sustainability in manufacturing & engineering

The Government's **Ten Point Plan for a Green Industrial Revolution** and 'Net Zero Strategy – Build Back Greener' set ambitious targets for improving sustainability and reaching net-zero by 2050. Along with mobilising investment and creating conditions for the private sector to invest with confidence, the government also introduced regulations to assure industry of the future demand for green products. Among the sustainable initiatives, the government has announced the end of the sale of new petrol and diesel cars by 2030.

There are exciting examples that show how the advanced manufacturing and engineering industries are responding to the challenge in the UK.

Historically, the manufacturing industry accounts for a high percentage of carbon emissions in the UK. Between 1990-2020, according to the ONS, manufacturing was the fourth-highest industry contributor to greenhouse gas emissions. However, according to the Annual Manufacturing Report 2020, **84% of manufacturing companies** see climate change and the drive for a carbon-neutral future as an **opportunity to embrace change** and transform their businesses[13].

A. Siemens UK: Wind Turbine Energy and Zero Waste in the North East.

With 25 sites across the country, the UK arm of global technology giant Siemens is committed to reducing its emissions, aiming to eliminate its CO2 emissions by 2030, source 100% renewable power and achieve 20% reduction in supply chain emissions – reaching 100% by 2050.

Currently, the company recycles 92% of its materials, with a 0% landfill waste capacity in Newcastle. Additionally, Siemens has spearheaded a number of national projects, including the Keele University Smart Energy Network Demonstrator, which is the largest grid in the whole of Europe, reducing 4,000 tonnes of carbon dioxide emissions per year. Moreover, the company has also created the nation's largest offshore wind manufacturing facility in Hull, responsible for providing wind turbines for wind farms in the North Sea and across the world.

B. 'Spirit of Innovation': Electroflight and Rolls-Royce - creating the battery for the world's fastest all-electric aircraft.

Aviation is top of the list when it comes to the need for electrification. Industry leader Rolls-Royce has partnered with Electroflight to create 'The Spirit of Innovation' – an all-electric aircraft that broke new records in January 2022 as the world's fastest electric plane, reaching speeds of 387.9mph. This landmark project for the industry was supported by the research team at WMG, the University of Warwick, who carried out extensive testing and provided facilities for the record-breaking attempt at their facilities.

C. Jet Zero Council.

A partnership between the aviation industry and the UK Government, launched in 2020, has set to reach net-zero aviation by 2050. This initiative has the potential to unlock nearly 5,000 jobs around the country, with £84.6 million investment from UK Government and industry.

D. The UK Battery Industrialisation Centre.

Based in Coventry, this publicly funded, open-access national battery manufacturing development facility can be used by any organisations working on batteries, including electric vehicles, rail, aerospace, energy storage and domestic equipment companies. The main goal is to allow those organisations to test whether their advanced technologies can be scaled up successfully prior to seeing if they are suitable for mass production. Part of the UK Government's Faraday Battery Challenge, the project is a pioneering concept in the race to develop battery technology for a greener future.

E. Zero Emission Vehicles

The UK is aiming to be the fastest G7 nation to decarbonise vehicles. It is currently amongst the top ten countries worldwide for electric vehicle growth and penetration rates, and fourth in Europe for the number of AC and DC charging installations for electric vehicles[14].

[13] Atmospheric Emissions: greenhouse gases by industry and gas, The ONS

[14] Zero Emissions Vehicles, great.gov.uk

Any questions?

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