



Advanced Manufacturing Pitchbook

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Introduction: The West Midlands – the Heart of Manufacturing

The West Midlands is the centre of the UK’s manufacturing and engineering industries; with manufacturing employing over 211,500 people - representing 11.3% of total employment locally, a proportion that is 43% higher than the national average of 7.9% (ONS 2019)*.

The West Midlands is leading the UK’s electrification of the automotive industry as well as advancing technology in connected & autonomous cars. Considerable investment has been made in the region by the UK government to support the development of autonomous driving technologies. The West Midlands is home to the UK’s Future Mobility Zone - the country’s most comprehensive on-road autonomous test-bed which covers 200 miles of road.

The West Midlands is at the epicentre of Europe’s largest infrastructure project - HS2. This High-Speed rail project is already creating a magnitude of supply chain opportunities for both large and small businesses locally.

Additionally, the West Midlands represents the UK’s first region-wide 5G testbed. WM5G (West Midlands 5G) manages collaborative industry projects to speed up the launch of 5G networks and supports industry to test, prove and scale-up new 5G products and services.

The West Midlands’ nationally significant manufacturing and engineering strengths are represented by industries including automotive, aerospace and rail. The region has notable expertise in power electronics, electrified powertrain, tooling, metals and industrial automation systems.

The region has a strong track-record in attracting inward investment across manufacturing, R&D and testing as well as HQ operations. In 2019, the West Midlands attracted 22% of all transportation manufacturing related projects; a significantly higher proportion than for the UK as a whole where just 5% of all projects in that year were in that sector.(EIM 2020)

Whilst the region has a diverse manufacturing and engineering base, the automotive industry represents the UK’s national centre of automotive capabilities. The automotive industry directly employs over 46,500 – a proportion of employment 5 times higher than the national average. Global OEMs include: Jaguar Land Rover, Changan Automobile, Geely, Aston Martin Lagonda, BMW and SAIC.

The machinery manufacturing industry is also significant, employing 23,500 people – double the average for the country as a whole. There is notable expertise in engines, turbines and fluid power equipment. Global manufacturers and engineering companies in this field include: GE Power Conversion, Quarteletz and IMI, a FTSE 250 company headquartered in Birmingham.

HS2 is a transformational high- speed project, representing a multi-billion-pound investment and huge supply chain opportunities. The West Midlands is also a central hub for the whole of the rail industry and across: digital rail, Light & Very Light Rail.

The West Midlands has considerable expertise in aerospace systems, particularly in control systems with key companies represented by Rolls-Royce Control Systems, Moog, Collins Aerospace and Meggitt.

The presence of energy and utility companies such as FTSE 100 companies National Grid and Severn Trent Water in addition to Cadent and E.ON has also led to considerable local supply chain opportunities ranging from power electronics applications to automation systems.

The region’s considerable manufacturing and engineering expertise across different industries and regulated industries enables access to a wide range of markets; not only automotive, rail, aerospace but in marine, offshore energy, defence, utilities and industrial applications.

The West Midlands’ central geographic position puts a large national market within easy reach as well as export markets; with exports representing £31.6bn worth of goods in 2019, ranked 3rd of all the English regions, behind London and the South-East.

**West Midlands combined 3 LEP geography*

A photograph of an automotive assembly line. In the foreground, a silver car chassis is being worked on by a large orange robotic arm. The background shows other car bodies and robotic arms in a factory setting. A dark grey semi-transparent shape is overlaid on the left side of the image, containing the word 'Automotive' in white text.

Automotive

Automotive: Introduction

The UK has a significant automotive industry – 1.3m cars and 2.5m engines were produced in the UK in 2019. Eight out of 10 cars made in the UK were exported overseas to 160 different markets worldwide. (note - 2019 data used due to impact of Covid on numbers in 2020)

The West Midlands exported £13.7bn worth of cars and parts in 2019 - almost double the number of any other UK region and representing 36% of the UK total (HMRC).

The top three export locations for the regional industry are:

- USA - £4.5bn
- Europe - £4.1bn
- China - £1.6bn

(HMRC Road Transport Exports, 2019)

The West Midlands is at the heart of the UK's automotive industry. Jaguar Land Rover's, the UK's automotive leading OEM by volume has its global HQ here as well as 2 car plants and 3 other plants and facilities. Aston Martin Lagonda, BMW Engines, Geeley (LEVC and Polestar) Changan Automotive and SAIC Motor Corporation all have a major presence locally. Activities range from production plants, head offices to R&D and Technical Centres.

The area has a deep and broad Tier 1 supply chain including Lear, ZF, AVL, Unipart and Gestamp. The supply chain is enhanced by a significant base of Tier 2, 3 and 4 suppliers and other innovative engineering and technology companies.

The West Midlands' central location positions 15 major OEM sites within 70 miles of the Gigafactory site in Coventry. The BMW Mini plant located within an hour's drive time as is the Toyota Burnaston site. The two major JCB sites (cab factory, dumpers and global HQ) are both under 70 miles away.

The strength of the local automotive industry is demonstrated by the number of employees in this industry. There are 46,500 employed in the 'manufacture of motor vehicles, trailers and semi-trailers. This represents a proportion of employment that is almost 5 times higher than the proportion for England as a whole. More specifically, Coventry & Warwickshire has over 8 times the proportion of employment in the automotive industry. This is in addition to the considerable number of people employed in the wider automotive supply chain.

Top 5 UK OEM by Production, 2019 (SMMT)

Make	Volume (2019)
Jaguar Land Rover	385,197
Nissan	346,535
Mini	221,928
Toyota	148,106
Honda	108,876

Jaguar Land Rover, West Midlands Plants & Sites

JLR West Midlands	Activity
Solihull	Production of F-PACE, Discovery, Range Rover, Range Rover Sport, Range Rover Velar.
Hams Hall Coventry Gaydon	Battery Assembly Centre Global HQ & Powertrain Design & Engineering Centre
Castle Bromwich Wolverhampton	Jaguar saloon & sports cars. Engine plant & the JLR Manufacturing Centre

The West Midlands: The Heart of the UK's Automotive Industry



A third of all cars produced in the UK come from production lines in the West Midlands. One in 4 engines in the UK are made in the West Midlands.

The presence of OEMs of locally has led to the development of a diverse supply chain, with over 21% of all the UK's automotive parts and accessories manufacturers situated in the West Midlands – the most of any UK region.

The West Midland's central position places it as an ideal location for serving the rest of the UK, with the for example the Oxford Mini Plant and Toyota Burnaston located just an hour away.

The drive to electrification and the West Midland's outstanding Connected and Autonomous Testbed is leading to considerable new investment into the region by existing companies as well as by OEMs and supply chain companies establishing a new presence in the locality.

Selected Local Principal OEM Plants & Sites	Miles from Gigafactory site
JLR HQ Coventry	3
Geely – LEVC	6
Dennis Eagle	12
JLR Gaydon	16
Aston Martin Lagonda	17
JLR Solihull	18
BMW Engines	20
JLR Castle Bromwich	25
JLR Hams Hall	25
JLR Engines	44
Toyota Burnaston	54
BMW Oxford	59
PSA Luton	67
JCB Uttoxeter	67
JCB Rocester	69

Source: Gigafactory: The Future of UK Automotive Production, CWLEP 2020

OEMs: A Strong Track-Record in Attracting Investment

A considerable track-record in attracting OEM new and re-investment

The significant number of OEMs based in the West Midlands and the drive to electrification has led to considerable re-investment locally as well as the attraction of new facilities. Recent investment has focused on electrification technologies, R&D and technical centres.

Jaguar Land Rover

Jaguar Land Rover has stated that the Jaguar brand will be all electric by 2025 and that it plans to spend about £2.5bn a year on new technology as part of its electrification strategy. JLR which has its global HQ in Coventry recently invested in a new Battery Assembly Centre at Hams Hall which opened in 2020 and one of the largest of its kind in the UK. At capacity, the facility will use 4 million 'battery' cells in production every day.

- In 2019, JLR invested in a state-of-the-art Advanced Product Creation Centre in Gaydon which incorporates vehicle design, engineering and purchasing functions. The centre is home to almost 13,000 engineers and designers who are developing the current and next generation vehicles.
- JLR's parent company, TATA opened the HQ of its European Innovation & Development Centre in 2017. This centre which employs over 1,000 staff provides technology support for JLR, the wider automotive sector and other industries including aerospace and heavy machinery. Main activities undertaken on site includes the whole design of car engineering systems – from exterior to interiors and the whole powertrain. The centre works with VW (Germany), Ford (China) and in the UK McLaren and Lotus with clients in other sectors including Cummins, Caterpillar and John Deere. Other areas of expertise includes software development and Human Machine Interface technologies.

Aston Martin Lagonda

- The company's global HQ, design centre and plant is located in Gaydon. Aston Martin is launching a new pure-electric sports car and SUV by 2025. All of its battery sports cars will be made at its plant in Gaydon. In 2021 Aston Martin returned to Formula One, under the Aston Martin Cognizant Formula One™ Team. The constructor team is based at Silverstone, a 39 minute drive time from the HQ in Gaydon.

Geely – LEVC (London Electric Vehicle Company) and Polestar

- LEVC represents the UK's only dedicated EV factory where the London Taxi is made. The site also includes HQ functions and a significant R&D centre. In 2020 in LEVC launched the first in a line of new commercial electric vehicles, with VN5 representing the growing 'one-tonne' van sector.
- Polestar, a Sino-Swedish automotive brand jointly owned by Volvo Cars and its parent company Geely, in 2019 opened a new R&D centre near to LEVC's HQ. Polestar's facility supports the development of the next generation of the brand's all-electric models, particularly focussed on light-weight, multi-material performance car engineering.

Changan Automobile

- Changan is one of China's traditional 'top 4' automobile companies which in addition to manufacturing its own vehicles, operates joint ventures with Suzuki, Ford, Mazda, Volvo and PSA Peugeot-Citroen. In 2016, Changan established the global HQ and R&D Centre of its powertrain division in Solihull.

OEMs: From Car Plants to Assembly and R&D

SAIC Motor Corporation

- SAIC Motor is the largest automotive manufacturer in China. It has a technical centre located in Birmingham. The centre which employs over 250 people is responsible for key phases of the engineering, research, design and development programmes for all new SAIC products worldwide. Including their MG and Roewe car brands.

BMW Engine Plant, Hams Hall

- The BMW plant in Warwickshire makes three and four-cylinder petrol engines at the rate of one per minute and supplies to nine car plants globally, from Oxford (Mini) to Germany and the US. The site also machines specific engine components, producing more than a million engine parts a year to supply other engine factories in Germany and Austria. Hams Hall is now taking on production of BMW's V8 and V12 engine family, the latter used in the Phantom and Ghost is currently built in Munich and then shipped for installation to Rolls-Royce's factory at Goodwood, West Sussex.

Other Commercial Plants

Dennis Eagle (Terberg RosRoca Group)

- Dennis Eagle has its HQ and plant in Warwick from where it developed and makes the eCollect - the world's first all-electric Refuse Collection Vehicle. Dennis Eagle manufactures over 1,000 units per year for UK local authorities and private sector contractors as well as in export markets including Australia and the USA. The company has been working with Transport for London (TfL) to develop an Urban Safety Vehicle range which currently includes skip-loader, tipper and tipper grab variants.

Mecalac

- Mecalac is a French owned manufacturer of wheel excavators, crawler excavators and wheel loaders and has a production plant in Coventry. The company also produces versatile and space-efficient off-highway products particularly for the US market. The company has recently launched the e12, a fully electric excavator using lithium iron phosphate (LiFePO4 or LFP) battery technology

Norton Motorcycles (TVS Group)

- Indian owned TVS Group which acquired Norton Motorcycles in 2020 and in 2021 opened its new HQ and Technical centre located in ~Solihull. The new facility is home to design, engineering, production, purchasing, sales, marketing, and support teams.

Automotive Expertise: Specialisms

The West Midlands has a considerable base of Tier 1 to Tier 4 automotive suppliers with notable sub-sector strengths in:

- Powertrain & battery propulsion
- Prototyping & product design
- Connected & Autonomous cars

A number of selected companies in each sub-sector are listed as follows. These represent Tier 1 as well as innovative small to medium sized businesses.

Connected & Autonomous Vehicles

Westfield
Aurrigo (RDM Group)
Triggo Mobility
ZF
Conginental
IPG Automotive
Eatron Technologies

Powertrain & Battery Propulsion

Jaguar Land Rover
BMW
Hofer Powertrain
Unipart Powertrain
AVL
Denso
Aston Martin Lagonda
Ricardo
Changan
Hyperbat
Potenza Technology
LEVC

Prototyping & Product Design

RDM Group
ZF
CAB Automotive
Ricardo
SAIC Motors
ARRK Europe
HPL Prototypes
CAD CAM Auto

Track Record: A Deep and Broad Base of Tier 1 Suppliers

The presence of global OEMs in the West Midlands has led to the establishment of a large Tier 1 supply chain which in turn is creating opportunities further down the supply chain and for innovative start-ups and small businesses. These companies supply OEMs across the country including Jaguar Land Rover, Honda, Nissan and BMW. The proximity of F1 constructor teams means there is also a base of companies serving this innovative industry, including ZF and Ricardo.

The West Midland's strengths in metals is demonstrated by the presence of companies including Gestamp, Stadco and Liberty Pressing Solutions.

OEMs and the supply chain are supported locally by a base of world leading R&D and innovation assets including HORIBA MIRA, Warwick Manufacturing Group (WMG), the Advanced Propulsion Centre, MTC (Manufacturing Technology Centre), UKBIC and the universities including the University of Birmingham and Aston University. The considerable innovation ecosystem has helped to attract commercial investment in R&D and technical centres as well as in testing facilities.

In 2018, AVL invested in a new 16,000 sq. m. Advanced Centre for Engineering and Testing Excellence Centre in Coventry. The Centre includes state-of-the-art testbeds for advanced powertrains, including hybrid and battery electric vehicles.

Most recently, ZF is reinvesting locally and has acquired a 9-acre site at Blythe Valley Park, creating a new ZF UK Hub. The latter is a multi-disciplinary, multi-divisional site specialising on the development of key technologies and system solutions for Active Safety Systems including: Advanced Driver Assist Systems, cyber-security, electronics, braking and steering systems as well as powertrain solutions and race engineering.

LG Electronics has its Vehicle Component Solution R&D centre at Warwick Science Park. LG is bringing in new technologies from the consumer to the automotive sector including in-car entertainment systems and telematic devices.

Selected Tier 1 Automotive Suppliers

Tier 1 Supplier	Activity
Lear	Seating & Electrical Distribution Systems
RDM Group	HQ and Advanced Engineering Centre for the design, development and supply of electronic control units.
Unipart Group	The Coventry site includes Unipart Powertrain Components and Unipart Powertrain Applications which manufactures tubular assemblies for powertrains.
LG Electronics	Infotainment, telematics and electrification.
Faurecia	The company is based in Litchfield where it makes interior systems, including automotive seating technologies.
Magna	Magna has a major exteriors and interiors plant located in Redditch.
Gestamp	Design, development and manufacture of highly engineered metal components.
AVL List GmbH	Simulation and testing of all types of powertrain systems - hybrid, combustion engine, transmission, electric drive, batteries, fuel cell and control technology.
Denso Automotive	R&D and testing centre for powertrain, infotainment and safety systems, thermal and rotating machines.
Brose	Mechatronic components and systems for seat, door systems and windows.
ZF Lemforder	The plant in Walsall makes driveline and chassis components
ZF Automotive	The site in Solihull includes ZF Cyber Security division and ZF Race Engineering which provides test & analysis services including in lightweighting and performance enhancement.
Rimstock	Design, manufacture, and supply alloy wheels. Its aftermarket alloy wheel brand Team Dynamics is eminent in motorsport
Pirelli	Tyre development, manufacturing and Performance Centre
Dräxlmaier	Sites in Solihull and Kenilworth - the former supports the system assembly process for car interiors and the latter manufacture and assembly of engine harnesses
Stadco	Low to medium volume stamping and assembly operation' and panel manufacture
Liberty Pressing Solutions	Design and manufacture of automotive steel and aluminium pressings, body-in-white (BIW) and welded assemblies.
Cab Automotive	Based in Dudley, the company designs and manufactures of interior components
Ricardo	The Midlands Technical Centre specialises in NVH (Noise, Vibration & Harness) and test facilities and is also the Ricardo Motorsports HQ.
Sertec Group	HQ and plant. Manufacture of busbars and modular cartridges for EVs at low volume.

Innovative Automotive Solutions: From Digital to Tooling

The West Midlands has a strong and diverse base of engineering and manufacturing businesses supplying into the automotive industries as well as other industries including aerospace, utilities, defence and marine.

The strength of the automotive industry and the innovation support available through the universities, the Catapults and HORIBA MIRA has also led to a number of international technology companies setting up locally. These include Clear Motion, Intrepid Control Systems and most recently in February 2021, Israeli company REE Automotive (REE).

REE Automotive has established a new state-of-the-art Engineering Centre of Excellence at Mira Technology Park. REE's disruptive corner technology enables a completely flat and modular chassis that supports all mission-specific EVs from class 1 to class 6. REE's EV platforms provide maximum room for passengers, cargo and batteries.

Other specialist companies include Vocis and DriveRightData, an independent fitment data provider to the wheel and tyre industry. Vocis specialises in providing advanced solutions for vehicle drivelines covering; control systems software, hardware and actuation hardware, prototype transmission design and build, vehicle application and calibration.

Other recent investors include US-owned IPG Photonics which established its new HQ In Coventry in 2019. The company makes high-performance fibre lasers and amplifiers for a number of industries. Its fibre laser tools for the automotive industry include applications for common cutting, welding, marking, engraving and brazing processes. Their technologies are also used for value-added remote welding and seam welding and tube and profile welding processes.

Selected Automotive Suppliers

Company	Activities
HPL Prototypes	Vehicle design & engineering and prototype manufacturing
CAD-CAM Automotive	Design and manufacture of low-volume and prototype press tools for the motor industry
Intrepid Control Systems	Provider of high technology software, hardware and services for data logging, diagnostics, test and validation
Hankuk Carbon	Development of Prepreg Compression Moulding materials for industries including marine and automotive
Adient Seating	Adient Seating (formerly the automotive seating business of Johnson Controls Group), a ~Tier 2 supplier has a major automotive seating plant at Wednesbury
IPG Photonics	Developer and manufacturer of high-performance fibre lasers and amplifiers for diverse applications in markets including aerospace, nuclear, semiconductor and automotive
Clear Motion	US owned company specialising in suspension technology, road surface mapping and ~ active seating motion control.
Potenza Technology	EV powertrains including battery management systems integration, control & safety.
Vital Auto	Automotive design studio
Lightning Hybrids Int'l	Manufacturer of hydraulic hybrid technology for harnessing brake power
Petford Group	Automotive tool manufacturing and injection moulding
Castings PLC	HQ and production site. Iron castings and machining group including CNC Speedwell
Alucast	Headquartered in Wednesbury, the company specializes in sand, gravity and high-pressure castings
Oxford Vision & Sensor Technology	Machine vision systems for automotive manufacturing and other industries
Hofer Powertrain	Provider to OEMs and to Tier 1. HQ, design and engineering of powertrains, including providing a high-performance dual-clutch transmission for McLaren
Eatron Technologies	Software products and solutions company specialising in electric and autonomous vehicles.
Autins Group	Development and manufacture of lightweight thermal and acoustic insulation materials to enable manufacturers to make vehicles that are lighter, quieter, and more thermally efficient.



Automotive The Opportunity

Electrification: What is the Opportunity?

The UK government is a global leader on climate change commitments, with an announcement in April 2021 that could see the UK cut carbon dioxide by 78% by 2035 from 1990 levels. The sale of new petrol and diesel cars being phased out in the UK by 2030 is creating significant new opportunities for the electrification of the supply chain and the development of new technologies.

The UK's Advanced Propulsion Centre (APC) identifies three key areas of the electrified powertrain (batteries, electric machines and power electronics) as being the most significant from a cost, functional and performance perspective - representing a value of opportunities of £24bn in the UK over a 5-year timeframe and a global addressable market forecast to reach £97bn in 2025.

The West Midlands is leading in electrification technologies. The presence of global automotive companies in the region as well as the considerable R&D and innovation assets is supporting a collaborative approach to the development of new technologies. Jaguar Land Rover has stated that it plans to spend about £2.5bn a year on new technology as part of its electrification strategy.

The automotive strengths of the UK and the market opportunity led APC (The Advanced Propulsion Centre) to identify a £24bn UK supply opportunity in the road to electrification.

Batteries represent circa 40% of an electric vehicle's value and so is creating considerable supply chain opportunities – from cathode and anode manufacturing to cell assembly and battery packs.

Investment and technology developments in batteries was a major driver for Britishvolt to establish a 5000 sq. m. facility to house its global HQ and technical centre at Mira Technology Park. The company has a world-class capability in battery development, enabling end-to-end engineering and test solutions for cell, modules and complete battery packs.

In 2018, Hyperbat Limited, a JV between Williams Advanced Engineering and Unipart Manufacturing Group established a new factory in Coventry to produce battery systems for the automotive industry including for Aston Martin's Rapid E vehicle. Capacity will be approximately 10,000 packs per year.. The support of APC was fundamental to the success of this project.

Strategic UK Opportunities in Passenger Car Electrification, APC 2020

Value	Areas of Opportunity
Batteries £12bn	Cathode Materials Refining Cathode Manufacturing Anode Manufacturing Electrolyte Manufacturing Cell Assembly Battery Pack Components
Power Electronics £10bn	Semiconductors Sensors High Performance Passive Components
Electric Machines £2bn	Magnet manufacturing Electrical Steel Electrical machine assembly and testing

Electrification: The Opportunity - Batteries

The UK's Advanced Propulsion Centre has identified that batteries represent a £12bn UK opportunity up to 2025;

Key opportunities include in cathode and anode manufacturing, electrolyte supply, as well as in final cell assembly. Additional opportunities are within the supply of components for battery modules and packs.

The Gigafactory, Coventry

With batteries representing circa 40% of an electric vehicle's value this is leading to considerable investment in battery manufacturing capabilities. The Gigafactory site is located at Coventry Airport and represents the potential for 4.5 million sq. ft. of commercial space. The Coventry Gigafactory is a joint venture partnership with Coventry City Council and Coventry Airport Ltd.

The Gigafactory is located adjacent to Jaguar Land Rover's global HQ and to the UKBIC – positioning the site as an ideal location for a battery plant. Outline planning permission is currently being submitted for the site.

As well as the opportunity to collaborate with UKBIC, the West Midlands provides the ecosystem to support a battery manufacturer from design to battery recycling (see Sector Ecosystem).

UKBIC (UK Battery Industrialisation Centre), Coventry

The £130m UK UKBIC in Coventry is a unique facility to support the development of battery technology from prototype scale to mass production. UKBIC is a key part of the Faraday Battery Challenge, a UK Government programme to fast track the development of cost-effective, high-performance, durable, safe, low-weight and recyclable batteries.

An Outstanding 18,500 sq. m. Industry Open Access Facility

The open access facility supports industry and university collaborations in the development and manufacture of batteries for the automotive industry but also for other applications including aerospace, with work being undertaken in solid state battery technology.

The facility has a Module and Pack assembly line to enable customers to test and produce low in volumes of Cylindrical and Pouch cell battery technology and provides cutting-edge processes that would be found in a high throughout battery assembly plant.

In addition, it has the capacity to produce 50 modules and 2.5 packs over every 8-hour shift. The line has manual and automatic workstations; and has cylindrical cell 'pick and place' capability, for cell voltage testing and impedance, as well as the ability to place cells into a module in either combination of cell orientation.

A state-of-the-art laser precision specialist welder is available for welding cells to busbars at industry relevant speeds and accuracy. In addition, the line has pioneering battery leak functionality, which allows leaks to be more easily discovered prior to full scale up. The facility can also accommodate future customer requirements such as alternative joining technologies and plasma cleaning.

UKBIC currently employs 86 people, including battery technicians, engineers and consultants, with plans for that number to reach 100 to support future project partnerships with industry and research organisations. UKBIC also provides training relating to the battery manufacturing training process.

UKBIC is working with Llika, a company specialising in solid state battery technology in the production of Goliath sold-state pouch cells. Llika is developing solutions for applications such as Industrial IoT, MedTech and Electric Vehicles.

The Opportunity: Power Electronics & Electronic Machines

Power Electronics – a £10bn UK opportunity

The Advanced Propulsion Centre identifies power electronics as representing a £10bn opportunity in the UK's automotive supply chain up to 2025, with EV's requiring high-performance power electronics (for inverters, converters and charging equipment) based on compound semiconductors such as SiC (silicon carbide) and GaN (gallium nitride). Sensors are a key market opportunity with other specific opportunities including:

- New SiC fabrication technologies
- High performance passive components such as inductors and capacitors

The increase in automation in new cars and in driver assist features is considerably increasing the number of different sensors being used in new cars. The global automotive sensor market size is expected to reach \$39.41bn by 2027 (Global Newswire 2020). Sensors have a number of applications including temperature, pressure, motion and speed. There are 3 categories of automotive sensors:

- Radar sensors (Radio Detection & Ranging)
- LiDAR sensors (Light Detection and Ranging)
- Camera sensors including 3D cameras

The West Midlands has considerable expertise in power electronics with companies including:

- Jaguar Land Rover's Powertrain Centre in Coventry where power electronics systems are designed for powertrain electrification applications across multiple car lines.
- ZF Group, Solihull - a leading developer of radar and LIDAR sensor systems.
- CRRRC Times Electric, a developer of control systems is focussing R&D activity on semiconductor based products for industries including automotive, aerospace and power distribution.
- Hofer Powertrain is collaborating with WMG, McLaren Automotive and Yasa Motors through an APC funded project on the design and manufacture of advanced hybrid transmissions.
- Changan – global HQ and R&D centre of its Powertrain Division
- Aeristech – this innovative company is developing breakthrough engine turbocharging technology.

Metal Housing for Power Electronics

- As well as the wider opportunities relating to power electronics; the strengths of the West Midlands in metal fabrication provides opportunities for suppliers making housing for power electronics.

The Opportunity: Power Electronics & Electronic Machines

Electric Machines – a £2bn opportunity

The Advanced Propulsion Centre has set out the main opportunities in the UK supply chain as representing £2bn by 2025. The three most significant opportunities are highlighted as being:

- Magnet manufacturing
- Electrical steels (or soft magnetics)
- Electrical machine assembly and testing, including stator winding and housing manufacture

Magnets represent approximately 40-50% of the cost of materials each electric machine – these costs are leading to innovative solutions in reducing costs, as is being pioneered by the University of Birmingham. The University's Magnetic Materials Group is the only UK research group focussed on processing and recycling of permanent rare earth magnetic materials.

- Hypromag Ltd, a University of Birmingham spin-out founded in 2018 is developing a full recycling supply chain for rare earth magnets based upon neodymium iron boron (NdFeB). Hypromag is supported by 25% shareholder, Maginito Limited, a subsidiary of AIM/TSXV listed Mkango Resources and technology metals investor, Talaxis. Hypromag Ltd is now working with the University of Birmingham on a three-year research project with Bentley Motors to deliver a sustainable source of rare earth magnets for electric and hybrid vehicles.
- Electrical steels (or soft magnetics) are key to almost all automotive electric machines. The IP to manufacture thin, silicon-based electrical steels resides in the UK, even though the steels are not produced here currently. A key capability in the West Midlands to support this area is stamping.
- Gestamp has one of the biggest hot stamping lines in the world at its new manufacturing facility near Wolverhampton. The plant also manufactures aluminium parts in an innovative transfer servo press, including battery boxes for electrical vehicles.
- C Brandauer & Co in Birmingham is stamping laminations for electric motors, with ambitions to scale up this capability.

Autonomous Vehicles: The Opportunity

The West Midlands – a leader in the development of autonomous vehicles

The autonomous car market is expected to reach \$1,642.9 bn in 2025. (Research & Markets 2020). Key to the growth of the industry is increasing R&D investments and technological innovations as well as supportive government initiatives.

The UK government has been key in supporting the West Midlands in developing the infrastructure for the development of autonomous driving technologies and as such is the UK region that was chosen as the country's First Future Mobility Zone.

The Midlands Future Mobility Zone

This Zone represents the UK's Future Mobility Zone and the country's most comprehensive on-road trialling environment, covering over 200 miles (350 kilometres). This national testbed enables CAV developers to trial autonomous solutions and commercialise their technologies.

The Zone covers a diverse road network including urban, inter-urban, campus and highways. Vodafone is partnering with the Midlands Future Mobility (MFM) consortium to deploy new 5G coverage along 186 miles of urban, rural and highway roads.

The West Midlands 5G enabled CAM Testbed enables V2V (Vehicle to Vehicle) and V2X (Vehicle-to-everything communications). In addition, the Midlands Future Mobility (MFM) 5G Research Services has a dedicated 5G research team to support industry in the development of trials.

Centre for Connected & Autonomous Automotive Research

The Centre for Connected & Autonomous Automotive Research at the MIRA Technology Park is a partnership with HORIBA MIRA and Coventry University (see R&D and Innovation). The Centre brings together OEMs, their supply chains and technology companies to collaborate on technological solutions for autonomous vehicles. HORIBA MIRA works with industry to design, build, test and validate their CAV solutions through the use of simulated validation and physical test-beds.

Vehicle Trials and Commercial Technology Development

A number of connected autonomous vehicle trials have already taken place locally. These include: the UK's first multi-OEM self-driving vehicles in Coventry city centre; Jaguar Land Rover and TATA Motors' fully self-driving navigation around Coventry ring-road; freight vehicle communication with traffic signals in Birmingham; and last mile slow speed pods at various locations across the region.

Access to this world leading CAV test-bed as well as a dedicated 5G Research Team is creating a cluster effect that is establishing the West Midlands as the Europe's key location for CAV-related organisations and companies.

These include Conigital and ZF. The latter, which has a major R&D and Technical Centre in Coventry, is a leading developer of self-driving hardware and software, from sensors to complete autonomous shuttles. ZF also specialises in advanced driver assistant systems as well as passive safety technology, making us one of few market actors to support all automation levels from L0 – L5.

Conigital, headquartered in Birmingham is provider of integrated and inclusive connected automated transport platforms. Other examples of autonomous vehicle commercialisation include:

- RDM has its own test centre: a facility dedicated to the testing of RDM's autonomous vehicles – the Aurrigo brand. The company has developed a 10 seat autonomous vehicles. The AUTO-POD® is a four seat autonomous pod designed for first and last mile transportation in urban areas, science parks, university campuses for example. The AUTO-SHUTTLE has a top speed of 50kmph, can keep up with city traffic and service roads around larger complexes or as a connection between existing mass transit stations and the places people want to go. Launched in 2020, AUTO-POD® is currently in service.
- Westfield Technologies – developer of the Westfield POD, the UK's first fully autonomous vehicle for first mile – last mile transportation. The POD has been developed in conjunction with Heathrow Airport and utilises the base technology platform from the work completed by ULTra PRT (Personal Rapid Transit).
- Triggo Mobility – development of a highly manoeuvrable, light electric vehicle designed for congested traffic. Its fully connected, drive-by-wire system allows fleet operators to reposition vehicles remotely through platooning and tele-operations.

Industry Collaboration: A Strong Automotive Ecosystem

The West Midlands is a leader in electrification and low carbon technologies.

There is a considerable ecosystem of R&D and innovation assets supporting industry collaborations and providing test-beds and state-of-art laboratories. These include the National Automotive Innovation Centre (NIC), The Advanced Propulsion Centre (IPC), MTC, WMG, HORIBA MIRA, the universities of Birmingham, Warwick, Coventry, Wolverhampton and Aston amongst others.

The UK's first 'Future Mobility Area' was established in the West Midlands and positions the region as the UK's location for trialling autonomous technologies. This brings together future innovative transport schemes, including alternative fuel, electric vehicles, electric bicycles, autonomous vehicle testing and other technologies which can be trialled locally.

A Joined-up Ecosystem

The local innovation ecosystem supporting the automotive industry is considerable – both from enabling a collaborative environment as well as providing access to state-of-the-art facilities and funding. This ranges from collaborative space at The National Automation Innovation Centre to the MTC and the Advanced Propulsion Centre (APC). The latter brings together consortia of OEMs, Tier 1 and small businesses with academia to collaborate on the development of low carbon propulsion technologies.

The APC invests in projects low carbon emission technology projects, provides technological support and strategic business advice. Presently the APC has supported 36 major R&D projects worth a total of £589m, with schemes including the Automotive Transformation Fund.

The West Midlands' Electrification Task Force chaired by WMG position the West Midlands as the UK's leading region on vehicle electrification. It works with Government on the direction of future innovation infrastructure and R&D policy and funding in order to secure the necessary investment to maximise the impact on the region's supply chain.

WM5G works with industry in managing collaborative industry projects to speed up the launch of 5G networks and supports industry to test, prove and scale-up new 5G products and services

The Energy Systems Catapult headquartered in Birmingham chairs the Electric Vehicle EV Energy Taskforce which brings together the national energy and automotive industries to plan for the changes that will take place as a result of rising electric vehicle use. The West Midlands' automotive innovation ecosystem will be further enhanced with the establishment of a new Mobility Innovation Accelerator due to open at Mira Technology Park later in 2021. The Accelerator will focus on electrification, CAV and Industry 4.0.

National Automotive Innovation Centre

The National Automotive Innovation Centre at the University of Warwick is a partnership between Warwick Manufacturing Group (WMG) Jaguar Land Rover, and Tata Motors European Technical Centre.

The 33,000m² centre includes collaborative workspace, workshops, laboratories, virtual engineering suites and advanced powertrain facilities. The collaborative nature of the centre encourage innovation in new technologies for future vehicles.

Rail

Rail: Introduction

The UK’s rail industry is growing from strength to strength, with considerable investment in metro, Very Light Rail and most importantly HS2.

HS2 is a transformational project, representing a multi-billion pound investment. This new state-of-the-art high-speed rail network will reach speeds of 230mph, with Phase 1, the line between Birmingham and London (a 38-minute journey) is planned to open in 2029. Phase 2 to Leeds and Manchester are planned to open towards 2038.

In 2019/20, UK government funding in the rail sector represented £11.1bn - an increase of 6.2% from 2018/19. During the course of the last 20 years, rail journeys increased by 89% to reach a record 1.8bn journeys in 2018/19 but declined to 1.7bn 2019/20 (decrease related to the impact of Covid-19). Rail use in the UK has increased faster than any other mode of transport (Department for Transport).

The West Midlands is at the epicentre of the UK’s rail industry, with HS2 representing Europe’s largest infrastructure project.

The region is also at the centre of an expanding network of Light Rail through the West Midlands Metro; with up to 50 new trams planned as part of an £83.5m investment which will also create opportunities in new control, communications and passenger information systems.

In 2016, HS2 established its headquartered in Birmingham and since opening has led to the considerable cluster of rail related engineering consultancies establishing and growing their presence locally. These include Jacobs, AECOM, Mott MacDonald, Arcadis, Bechtel, Balfour Beatty and Arup.

An hour away in Derby is Alstom Rail (formerly Bombardier) who design, develop, manufacture electric and diesel trains including the AVENTRA range. Also nearby is DB ESG, who provide rail technical and technology integration services. Porterbrook, headquartered in Derby recently took over the management of the Quinton Rail Technology Centre in Warwickshire.

The West Midlands Combined Authority area has the highest number of railway related jobs of any combined authority in the UK with nearly 40,000 jobs. Rail supply is the largest sub-activity of this, making up 43% of railway-related GVA (£850m), followed by railway systems with 32% of GVA (£650m).

(Source: Oxford Economics)

Selected Rail Sector Companies & Organisations, West Midlands

Organisation	Activity
HS2	Construction & procurement HQ, Network Integrated Control Centre and Maintenance Depot.
Siemens Mobility	Rail control systems - connected mobility infrastructure and software services.
Wabtech Control Systems	Advanced railway asset monitoring and management systems.
CAF Rail	Light rail design and manufacture
AM Rail Group	Railway signalling design on both Mainline and Metro Systems.
Severn-Lamb	Design & manufacture of Ultra Light Rail Cars.
Vivarail	Light rail design and manufacture.
Porterbrook	Rail leasing & asset management including Quinton Rail Tech Centre
Arrowvale Electronics	On Train Monitoring Recorder, Remote Conditioning Monitoring and Drivers Safety Devices.

The Opportunity: HS2 – at the heart of the West Midlands

HS2 represents a nationally significant market opportunity. In total, there are approximately 350 businesses currently in the local HS2 supply chain; ranging from large companies to small to medium sized businesses.

The rolling stock procurement will provide openings in areas including: design, engineering, technology and customer experience. Trains will be introduced into service from 2026.

Railway Systems – a £3bn opportunity

More widely within Railway Systems, this includes considerable commercial opportunities ranging from: power systems and transformers; to data transmission network and SCADA (Supervisory Control and Data Acquisition) systems. The main areas are as follows:

- Track and Overhead Catenary System
- Tunnel and Open Route Mechanical & Electrical Fit out and Ventilation
- HV Power Distribution
- Telecommunications (including Data Transmission Network and Emergency Services Radio Network)
- Command Control Signalling & Traffic Management
- Network Integrated Control Centre (NICC) & Washwood Heath Depot including train servicing

The HS2 main line train control will be ERTMS, (European Railway Traffic Management System) and controlled by the NICC at Washwood Heath. By 2022, HS2 will be putting in place a high-tech monitoring system to enable the remote supervisory control of railway assets and systems by key operational personnel. The Engineering Management System (EMS) will provide an integrated SCADA consolidating multiple SCADA systems. This will enable the monitoring of railway assets and systems in real time from the HS2 Network Integrated Control Centre in Birmingham.

The Opportunity: Innovation & HS2 supply chain

Innovation in High-Speed Rail

HS2 has established an Accelerator programme with the Connected Places Catapult and Innovation Birmingham to foster collaborative working with small and medium enterprises and the core members of the HS2 supplier network.

The Accelerator will drive innovation in the design & build of HS2; innovate railway operations to delivery world class leading customer experiences; and to build a legacy of knowledge, expertise and new commercial opportunities as HS2 is developed.

The Accelerator is based at the Bruntwood SciTech Innovation Birmingham Campus and offers:

- **Business development** opportunities and introductions to potential customers
- **Technical support** including access to technical experts
- **Investment readiness** – tailored investment readiness programmes with support from investment coaches
- **Funding advice** – including grant opportunities
- **Coaching and mentoring** – including VC support
- **Showcase day** – demonstration days to investors, industry and customers
- **Growth support** – 4 months tailored business support

The Accelerator has already had two waves of cohorts, with companies working on circular economy solutions, addressing productivity challenges and improving the station 'experience'.

Companies such as Buildots, Dendra Systems, Sensat and Cloudcycle have participated in the Accelerator and represent technologies ranging from drones, AI and the Internet of Things.

Buildots for example has developed wearable camera technology that uses Artificial Intelligence and state-of-the-art computer vision to automate the tracking of build progress compared to the design and schedule, while reducing and resolving disputes.

The Opportunity: Investment in Digital Rail

HS2 represents a considerable opportunity for companies to become part of the significant supply chain but also more widely within the rest of the rail industry and including: digital rail, Light & Very Light Rail and decarbonisation.

The West Midlands has considerable R&D and innovation assets to support the development of new technologies (see *R&D and Innovation Assets Chapter for more information*). Digital technologies are key to HS2 and across the rail industry in the UK and globally. Opportunities in digital rail systems range from remote telemetry units to drones with examples included below:

Digital Rail

- Connected Devices - Predictive maintenance and remote condition monitoring systems using sensors to underpin a data enabled railway
- Connected Operations - From in-cab signalling and driver voice communications, to trackside worker warning and enhancing level crossing safety.
- Connected Passengers - delivering the Internet connectivity needs of both passengers and Train Operating Company staff and systems.
- Connected Intervention - connected robotic devices and drones; delivering autonomous rail infrastructure intervention.

The Centre of Excellence in Rail Digital Systems, University of Birmingham

The Centre of Excellence for Digital Systems is a partnership with UK Rail Research and Innovation Network (UKRRIN). This national centre was opened in 2020 and received £16.4m in funding from Research England. It sits within the Birmingham Centre for Railway Research and Education (BCRRE) and brings together academic and industry to collaborate technological solutions for the rail industry and has recently established a collaborative partner with Siemens Mobility to advance the industrial applications of the University's academic research expertise.

Research specialisms include: Simulation technologies; Future railway operations & control; Data integration & cyber security; and Smart monitoring & autonomous systems. (See *university assets for more information*)

WM5G – a live testbed for trialling 5G enabled digital rail technologies

The advancement of new technologies enabled by 5G is critical to the rail industry – for example enabling effective real-time monitoring of the entire train systems. This is in areas such as predictive asset maintenance and condition monitoring as well as monitoring wear on the railway infrastructure and monitoring the peak electricity consumption times and distribution.

West Midlands 5G (WM5G)

A multi-million-pound programme that both the West Midlands Combined Authority (WMCA) and the Government (DCMS) have set-up to develop the UK's first region-wide 5G testbed. WM5G manages a number of projects to speed up the launch of 5G networks and test, prove and scale up new 5G products and services.

- WM5G has recently awarded a share of a £2.4m to a number of consortiums to deliver a series of 5G transport trials across the region. Current projects include: Rail Track Assess and Alert; Pantography & Line Assess and Alert and Very Light Railway Remote Monitor.
- WM5G has developed the UK's very first 5G-connected tram as part of a regional transport trial in partnership with West Midlands Metro, Transport for West Midlands (TfWM), GoMedia and Icomera. This Tram Safety operated by Digital Rail provides a cutting-edge CCTV Video analytics system to automatically alert staff.

The Opportunity: Investment in Light Rail & Decarbonisation

Light & Very Light Rail

The expanding network of the West Midlands Metro will lead to an additional 50 new trams planned as part of an £83.5m investment. This will also include opportunities in new control, communications and passenger information systems; including a 5G project using connected technology and smart sensors to quickly identify track and power line defects on the region's rail and tram networks.

In addition, HS2 will be putting in place a light driverless transport system between the new Interchange Station in Solihull to Birmingham Airport.

The Very Light Rail National Innovation Centre (VLRNIC)

The VLRNIC in Dudley is a dedicated facility to support the development and growth of the VLR industry. The Black Country Innovative Manufacturing Organisation (BICMO) was set up to establish this national innovation centre. The Centre includes a 2.2km test track and tunnel, conference space, research labs and an advice bureau to help local authorities and transport planners understand the benefits of VLR.

The Centre's test track and tunnel is being used to explore the development of autonomous trains and the use of 5G enabled technologies. The Centre is exploring how 5G can improve the safety of such autonomous trains through its real time applications. The project will trial a 5G connected control system which operators will be able to interact with and respond to in real-time.

Decarbonisation & Propulsion

As with the automotive and aerospace industry, the rail sector is working towards decarbonisation and electrification of the railways. At present, only 38% of the UK's railways are electrified.

The West Midlands which is leading in electrification technologies is also developing new propulsion technologies for the rail industry. The Birmingham Centre for Railway Research and Education (BCRRE) has been researching different options for fuelling rail vehicles. In 2020, the University in partnership with Porterbrook launched the UK's first Hydrogen train, the HydroFLEX.

In addition, there are a considerable number of other organisations and universities in the West Midlands supporting electrification and decarbonisation (see chapter on R&D and Innovation Assets).

The UK Battery Industrialisation Centre (UKBIC) in Coventry is a major development for battery manufacturing across sectors along with the Advanced Propulsion Centre based at WMG. The latter has a specialist focus on very light rail, battery and energy storage and light-weighting of materials.

Quinton Rail Technology Centre (QRTC)

QRTC is the UK's only privately owned and independent rail testing / trialling site. The 135 acre site in Warwickshire is connected to the national rail network, featuring engineering workshops and a 2 mile rail test track. Facilities are used for impact testing, product approval, product development and training. QRTC has been working with Cisco to develop a digital test bed that has enabled Cisco to build a number of global products and services, including some "world firsts" in terms of trackside to train data transfer. The QRTC is managed by Porterbrook. Porterbrook is investing £1bn of new capital in the UK rail sector in the coming years, with investment in areas including battery and hydrogen power.

Rail: A Strong Collaborative Ecosystem

The West Midlands is at the heart of the HS2 network and of the UK's rail industry.

The region had developed a considerable collaborative ecosystem to support innovation and the commercialisation of new technologies across the rail industry. This includes the HS2 Accelerator as well Europe's largest rail research group, the Birmingham Centre for Rail Research and Education.

The rail industry is supported by the UK's largest rail sector business organisation, the Rail Alliance which is headquartered in Birmingham.

An Ecosystem Supporting Innovation

The Rail Alliance is the UK rail sector's largest dedicated business to business networking organisation; bringing customers, suppliers and supply chain opportunities together. The Alliance which has over 830 members also collaborate UKRRIN (UK Rail Research & innovation Network) and the European Rail Clusters.

DIGI-RAIL, a business support programme within the Rail Alliance provides businesses with technical expertise, demonstration facilities, access to technology providers and rail industry buyers, and facilitates small-scale collaborative R&D partnerships to develop new digital rail products and processes.

The West Midlands Growth Hubs have established a HS2 'one-stop-shop' to provide a range of support to small to medium sized businesses, including an HS2 Ready audit, training and access to finance and procurement tools.

New entrants into the rail industry are supported not only by the West Midlands Growth Hubs but through the HS2 Accelerator. This considerable ecosystem means that it is easier for businesses to access commercial opportunities as well as being supported in the development of new technologies.

The Rail Alliance and the West Midlands Growth Company facilitates access to the university assets, including importantly, the Birmingham Centre for Rail Research and Education at the University of Birmingham.

Through its leading and collaborative role in the UK Rail Research and Innovation Network (UKRRIN), the University of Birmingham recently opened a Centre of Excellence for Digital Systems which brings together academic and industry capabilities to collaborate on advanced digital technologies for the rail industry. .

WM5G works closely with Transport for the West Midlands (TfWM) in supporting consortiums working on 5G rail enabled projects to also be access rail, tram and road infrastructure data available through TfWM.

Aerospace

Aerospace: Introduction

The UK's aerospace industry is the second largest in Europe and the third largest globally. The industry has an annual turnover of £33.9bn (ADS 2019) - the majority of which is generated from export markets.

The West Midlands represents a nationally significant cluster of aerospace control systems expertise. The HQ of Rolls-Royce Control Systems is in Solihull and Moog, Meggitt, Collins Aerospace are also based locally.

Local aerospace expertise includes systems that power aircraft – gas turbine engines and other propulsion systems as well as systems that control the moving parts of aircraft and engines – electrical, mechanical, hydraulic and pneumatic.

The region* is home to 25% of the UK aerospace industry and Rolls-Royce's global HQ and engine plant is located only 41 miles from Birmingham.

The West Midlands has considerable expertise in aerospace systems, as well as in specialist metals, tooling & design services.

The supply chain represents a diverse base of activity, ranging from metals (Thyssenkrupp Materials and Timet) and castings (Westley Group) to tool manufacturers (Guhrring) and precision engineered components (AE Aerospace and Mills). These support the large international manufacturers such as Airbus, BAE Systems, Boeing and Rolls-Royce.

A number of companies including Meggitt, Collins Aerospace, JJ Churchill and AE Aerospace also serve a number other highly regulated industries including defence, marine and nuclear.

The West Midlands strengths in automotive has also led to innovation from that industry being applied in the aerospace industry; particularly in light-weighting and precision components. For example, Colledge & Morley manufacturers precision gears and spline shafts for the F1 industry as well as for the aerospace, defence, medical and instrumentation markets.

Selected Aerospace Companies, West Midlands

Company	Activity
Rolls-Royce Control Systems	HQ, design & manufacture of control systems.
Moog	Control systems & electrical power systems.
Meggitt	Global HQ, control systems, braking systems.
Collins Aerospace	Global HQ for manufacturing of actuators and control systems.
Bromford Industries	Global HQ. Landing gear, power generation and aero engines
AE Aerospace	Precision engineered components
Timet	Titanium for aircraft engines
Guhrring	Tool manufacturer
Westley Group	Copper based sand; ferrous/ non-ferrous centrifugal castings
Arconic	Armour, tooling & aerospace plate
Nasmyth	Complex sheet metal, welded & machined assemblies
Colledge & Morley	Precision gears and spline shafts

** refers to Midlands Aerospace Alliance or Midlands Engine geography of East and West Midlands*

Aerospace: A strong cluster of global companies

Overview

The West Midlands is home to the HQ of Rolls-Royce Control Systems as well as other notable aerospace companies including Meggitt and Collins Aerospace. Rolls-Royce's global HQ and Engine Plant is located nearby in Derby. Rolls-Royce is working on developing the world's largest aero-engine (UltraFan) which will have a fan diameter of 140 inches and the potential to increase fuel efficiency by 25% compared to older engines. The carbon titanium fan blades and composite casing will also reduce the weight by up to 1,500 lb per aircraft.

Rolls-Royce Control Systems

Rolls-Royce Control Systems is headquartered in Solihull. The 25-acre site employs circa 1,000 staff with activities including R&D, manufacturing and software development. The site designs and develops safety critical controls and asset intelligence solutions for industrial power, marine, civil and military aerospace. This includes engine control software, electronic engine controls, fuel metering units, fuel pumps and engine actuators for a large number of commercial and military aircraft.

- Facilities include: electrical assembly, complex machining, testing for hydro-mechanical controls, chemical processing and laboratories.
- The Solihull site also supports the defence sector including the submarine Dreadnought control systems.
- The site is working on future programmes including a focus on the Ultra-Fan engine and development work is being undertaken around lean-burn combustion fuel nozzles.

Moog

- Based in Wolverhampton, Moog is listed as one of the world's 'top 10' companies in the global aerospace flight control systems market (Market Watch, April 2021) with clients including Airbus, BAE Systems, Boeing and Rolls-Royce.
- Activities undertaken in Wolverhampton includes: design, manufacture and assembly. Local capabilities includes: autoflight systems & equipment; control systems & equipment; electrical power systems & equipment; and hydraulic systems & equipment.

Meggitt

- Meggitt PLC is a FTSE 250 company headquartered in Coventry. Meggitt designs and manufactures technology solutions for aerospace, defence and energy applications, including: control, monitoring, braking and safety systems. The company recently re-invested in a major new site at Ansty Park which as well as being home to its global HQ includes the operations of aircraft braking systems and control systems. The Engineering and Manufacturing Centre of Excellence for future aerospace thermal management technology is also located on site.

Collins Aerospace

- Collins Aerospace, a subsidiary of Raytheon Technologies, has two sites in Wolverhampton. This includes the Actuation Systems factory and the Power and Control Systems operation in addition to HS Marston Aerospace. The latter is one of the world's leading suppliers in heat transfer and fluids management products for the defence, commercial aerospace markets and electronics industries.

Aerospace: An Ecosystem Supporting Technological Innovation

The driver of meeting new CO2 targets is leading the aerospace industry to increase its focus on light-weighting and the development of hybrid and electric propulsion systems. Hydrogen is expected to play a key role in aviation decarbonisation.

The West Midlands is a leader in electrification and low carbon technologies including hydrogen for transport applications in rail.

The region's national strengths in automotive including F1, means there is a considerable base of R&D and commercial expertise in low carbon propulsion and light-weighting with has a considerable cross over into the aerospace industry.

This positions the West Midlands as an ideal location for companies developing these technologies for the aerospace industry.

An Ecosystem Supporting Innovation

The Midlands Aerospace Alliance, based in Coventry, represents the largest aerospace cluster in Europe and underlines the region's strength in the sector with more than 300 members. The Alliance provides a collaborative environment for the industry to share ideas and best practice as well as helping members fund and run technology development projects.

There are a number of funding programmes to support industry, including through the Aerospace Technology Institute. The latter provides funding to accelerate innovation including £2.5m available through the NATEP competitions for micro, small and medium-sized businesses to carry out industry-led civil aerospace collaborative R&D projects. The Midlands Aerospace Alliance can help in bringing these together. *See section on funding.*

The West Midlands has considerable expertise in materials, particularly metals. The University of Birmingham hosts the Rolls-Royce University Technology Centre which is one of the UTCs working on the UltraFan engine. Additionally, the High Temperature Research Centre, a collaboration between the University of Birmingham and Rolls-Royce provides a unique casting, design, simulation and advanced manufacturing research facility.

The Advanced Materials and Composites Group at the University of Wolverhampton is focused on optimisation of materials for aerospace applications. WMG also has considerable expertise in materials and light-weighting technologies.

The Manufacturing Technology Centre which hosts the National Centre for Additive Manufacturing; is working on a government supported project to transform the use of additive manufacturing in highly regulated industries such as aerospace by developing standards for part quality, reliability, traceability and process repeatability.

The University of Birmingham is a key partner in a £54m UK collaboration programme (H2GEAR), led by GKN Aerospace to develop the company's first hydrogen propulsion system for sub-regional aircraft. The University of Birmingham also trialled the UK's first ever hydrogen powered train (HydroFlex) in 2020.

There is also considerable support for digital technologies. Coventry University is undertaking large-scale research with BAE Systems, General Electric, Rolls Royce and DLR into next generation flight deck technologies.

See Chapter on Innovation Assets for more information.



Industry 4.0

Industry 4.0: Industrial Automation Systems

Industry 4.0 involves the application of digital tools and technologies to the manufacturing process so as to make significant enhancements to performance and productivity. Technologies include robotics and autonomous systems, AI (Artificial Intelligence), cyber security and the Internet of Things (IoT).

The roll-out of 5G is leading to a growing uptake of Industry 4.0 technologies, with 5G having the capacity to support a huge number of connections simultaneously while improving speed, latency, reliability and power consumption for Internet of Things (IoT) devices.

The West Midlands is home to the UK's first region-wide 5G testbed. WM5G (West Midlands 5G) manages collaborative industry projects to speed up the launch of 5G networks and test, prove and scale-up new 5G products and services.

McKinsey* estimates that Industry 4.0 will account for sales of about 22 million 5G IoT units in 2030, with most applications related to manufacturing but with other key segments including smart city, smart energy and connected health. The West Midlands' 5G testbeds positions the region an ideal location for Industry 4.0 technology providers.

Industry 4.0 technologies, in particular industrial automation systems are well represented in the West Midlands, with expertise in areas including: telemetry, predictive maintenance systems and embedded systems.

The West Midlands' considerable manufacturing strengths; particularly in automotive, aerospace as well as the presence of national infrastructure companies such as National Grid, Cadent, E.ON and Severn Trent Water has led to the growing presence of companies developing Industry 4.0 technologies including in autonomous systems and control systems to serve these industries.

The automotive industry has been a significant adopter of robotic and autonomous technologies, with other industries such as food & drink, rail and utilities for example only recently starting to take-up such technologies – leading to opportunities for new entrants.

The adoption of Industry 4.0 technologies is likely to increase significantly with the roll-out of 5G. The Manufacturing Technology Centre (part of the UK's High Value Manufacturing Catapult network) with WM5G and other partners is installing a purpose-built private 5G network testbed which will allow manufacturers to explore the benefits from multi-edge computing and wireless connectivity in digital manufacturing and robotics.

In addition, Telent, a major provider of telecoms and digital infrastructure systems has 5G Private Network services and test facilities located within their Warwickshire headquarters.

Selected Systems Related Companies, West Midlands

Company	Activity
Kuka Systems	Automated solutions & robotic welding Rail control systems - connected mobility infrastructure and software services.
Siemens Mobility	Advanced railway asset monitoring and management systems.
Wabtech Control Systems	UK's Automation Centre
Schneider Electric	Telemetry systems for synchronous machines & condition monitoring.
Quartzelec	Robots, CNC controllers etc.
FANUC	Electrical control panel manufacturers
SM Control Engineering	Telemetry systems for remote locations
RS Hydro	Software & hardware and services for diagnostics, test and validation
Intrepid Control Systems	Systems Integrator
Callisto Integration	Machine vision systems.
Oxford Vision & Sensor Technology	Automation and Industrial control systems solutions
Wolf Automation	

**McKinsey, The 5G Era, 2020*

The Opportunity: Robotics & Autonomous Systems

The Global Industrial Robotics market accounted for \$39.64bn in 2019 and is expected to reach \$101.72 bn by 2027. Skills shortages and mitigating the adverse impact of COVID-19 has been increasing investments in automated systems. ([Global Market Outlook, ResearchAndMarkets 2020](#)).

Industrial robotics include applications for warehousing, assembly and inspection for hazardous environments. For example, locally headquartered Severn Trent Water is trialling robots to detect leaks in pipes. Autonomous drone systems technologies are being used for asset monitoring of power grids and railway infrastructure.

The West Midland's Robotics & Autonomous Systems Expertise

The UK government has been key in supporting the West Midlands to establish the state-of-the-art testbed infrastructure for the development of autonomous driving technologies. The West Midlands is home to the UK's First Future Mobility Zone which has the country's comprehensive on-road trialling environment - covering a network of roads stretching over 200 miles.

This unique national testbed enables CAV (Connected & Automated Vehicles) developers to trial autonomous solutions and commercialise their technologies. Locally based companies developing autonomous systems include Triggo Mobility and RDM's Aurigo 'AUTO-POD®'. The latter is a four-seat autonomous pod designed for first and last mile transportation in urban areas.

Robotic companies based in the West Midlands include KUKA Systems and FANUC. The latter is the world's largest manufacturer of industrial robots and has UK HQ at Ansty Park in Coventry. FANUC provides industrial automation solutions including CNC controllers, lasers, robots, machining centres, EDM and injection moulding machines. KUKA has two sites locally, with the Halesowen site providing turnkey solutions for automotive assembly lines.

Other locally based companies include:

- UAV Engines - engines for tactical UAVs, target drones and single mission platforms.
- Sorion Electronics - design and manufactures mobile robot management systems and guided assembly systems for manufacturing industries including automotive and aerospace.
- Robotix - robotic systems and industrial automation specialists
- Advanced Design Robotics - complete service to equipment manufacturers from concept and consultation through to programming and commissioning.

R&D & Innovation Robotics Expertise

The MTC has considerable robotics expertise and recently created Project Viper, a new robotic development which uses a deep neural network, low-cost depth cameras and robotic arms with vacuum pick-up cups. Tests on a attempted picks of wide range of objects including metal components and fruit were 94% of successful.

University robotics expertise includes The National Centre for Nuclear Robotics (NCNR) at the University of Birmingham. The Centre is developing state-of-the-art robotics, sensing and AI technologies for hazardous environments. The Extreme Robotics Lab is Europe's most prominent university lab dedicated to robotics for nuclear and other extreme environments.

WMG also has important robotics expertise. Its Shadow Robot Dexterous Hand research project is a robot hand, with size, shape and movement capabilities similar to those of a human hand. Novel artificial intelligence algorithms have been developed so the robot can learn how to manipulate objects just like humans do – making it ideal for applications in hazardous environments.

The Opportunity: IIoT & Industrial Automation Systems

The Industrial Internet of Things (IIoT) market is expected to grow \$77.3bn in 2020 to \$110.6bn by 2025 (Markets&Markets2021). The growth of the IIoT industry is being driven by technological advancements in semiconductor and electronic devices; and increased use of cloud computing platforms. The roll-out of 5G networks is set to considerably increase the take-up of IIoT technologies and AI, used for applications including condition monitoring and predictive asset maintenance amongst other areas. These are key technologies for the manufacturing industry, transportation, defence, energy and utilities – all industries that are significantly well represented in the West Midlands.

Industrial Automation Systems Expertise

Related technologies IIoT include for example: sensors, RFID, Distributed Control Systems, SCADA systems (Supervisory Control And Data Acquisition) and MES (Manufacturing Execution Systems) Locally based companies represent a range of technologies; and from multinationals to small to medium sized companies:

- Wolf Automation – automation and Industrial control systems solutions provider specialising in PLC programming, Motion Control, HMI / SCADA programming and control system refurbishment.
- Hitex Embedded Tools & Solutions – German owned company making embedded hardware for system development and optimisation.
- Embed Ltd – automotive systems developer including in developing safety critical systems
- HMS – Swedish owned manufacturers of network interfaces (modules and gateways) which connect industrial devices to different industrial networks.
- Industrial Switchgear – family-owned design, manufacture and delivery of electrical control panels across diverse industries and sectors.

- Performance Control Systems -design, manufacture and installation of electrical control panels
- R&R and sister company S M Control Engineering - electrical control panel manufacturers with the latter providing software engineering relating to PCs, PLC's, Telemetry, SCADA and networked systems.
- JAJO Automation Services – based in Wolverhampton, the company develops PLC & PC-based control systems.
- Quartzelec - electrical contractors with expertise in condition monitoring (Quartztec) and telemetry system for monitoring and protecting the rotor winding of synchronous machines.

Systems Integration

The West Midlands has a growing base of systems integrators including Callisto Integration. The latter is part of Accenture's Industry X.0 practice and is based at Warwick Science Park. Callisto's services include the design of manufacturing execution systems, industrial internet of things (IIoT) systems and SCADA and controls systems.

Other companies include:

- Cougar Automation - system integrator providing automation and control systems to industry, manufacturing and process plants (PLC, SCADA & MES).
- MCS Control Systems is a system integrator and develops PLC solutions, including SCADA, MES and PLC software as well as developing sensors.
- HORIBA-MIRA – specialist systems integration services for the automotive and defence industries

Industry 4.0: A Strong Collaborative Ecosystem

WM5G manages collaborative industry projects to speed up the launch of 5G networks and test, prove and scale up new 5G products and services.

Businesses in the West Midlands can benefit from being part of the UK's first 5G application accelerator - 5PRING. These open-innovation centres bring organisations with specific industry challenges together with start-ups and scale-ups, to incubate and accelerate commercially viable solutions to these challenges by leveraging 5G technology.

Other collaborative organisations supporting the development of Industry 4.0 technologies include Catapults and local universities.

An Ecosystem Supporting Innovation

The West Midlands is home to the UK's multi-city 5G test bed, with the region paving the way for the future rollout of 5G across the UK. This multi-million-pound programme supported by the West Midlands Combined Authority and the Department for Digital, Culture, Media and Sport (DCMS).

This investment is enabling the West Midlands is to trialling new 5G applications and services at scale. Recent collaborations with WM5G include with smart sensor provider Vivacity Labs, to validate the application and use of 5G-enabled smart sensors to accurately identify and classify road usage in real-time. As a result of the considerable amount of data gathered through over 500 sensors; state-of-the art prediction models can be developed to more accurately forecast traffic flow and reduce congestion in hot-spots.

The West Midlands is also home to the UK's first 5G commercial innovation hubs, with 5PRING centres in Coventry, Wolverhampton and Birmingham. 5PRING provides a collaborative innovation environment and de-risks the process of building a business case for real time monitoring and 5G sensor integration, by providing a shared space for conducting this type of research.

The MTC which has considerable robotics and digital manufacturing expertise; is part of the Smart Factory Innovation Hub (funded by UK Research & Innovation). This hub enables businesses to test the latest digital manufacturing solutions in a broad range of applications, before investment.

Eligible business can work with MTC to access the Catapult's equipment, technology and facilities. and use the Innovation Hub to test digital applications and early-stage technologies in a safe, industry-like environment with expert support.

In addition to WM5G and the MTC, the universities have considerable R&D expertise in autonomous systems and Industry 4.0 technologies. This includes the Institute for Advanced Manufacturing & Engineering at Coventry University; WMG Automation Systems Group with expertise including in automation, robotics, Industrial IoT and distributed controls systems and the Sensors and Control Research group at Birmingham City University

(see R&D assets).



R&D and Innovation Assets

R&D and Innovation: The Advanced Propulsion Centre

The Advanced Propulsion Centre (APC)

APC was established in 2013 as a £1bn joint investment between government and industry focussed on making the UK a centre of excellence for low carbon propulsion technology. Since its launch APC has funded over 110 low-carbon projects, involving more than 290 partners and supporting 36 major R&D projects worth a total of £589m.

The APC invests in projects low carbon emission technology projects (including battery technology, hydrogen fuels, motors & drives) with applications for cars, buses, heavy goods vehicles. Most recently in March 2021, APC announced £54m of R&D funding for projects including hydrogen-powered buses. As well as financial support, the APC provides technological support and strategic business advice.

APC provides a key role in supporting industry and academic collaborations by helping to build and advise project consortia including with OEMs, Tier 1 and smaller suppliers and universities. Locally based projects include those with Jaguar Land Rover, LEVC, Hofer Power Train and Shield Manufacturing Technologies. The latter was awarded £11.3m for a project to develop and manufacture energy-saving light-weighting technology from motorsport for use in cars and vans. Other examples include:

- LEVC – Electric Vehicle Evolution (Coventry): The London Electric Vehicle will develop a new battery designed specifically for its vehicles for higher performance and also to be reused and recycled.
- Ford Technologies Ltd – eSHADOW (Warwick): This project will determine the technical, financial and environmental challenges of using advanced, lightweight materials in vehicle manufacturing
- Jaguar Land Rover – Hi-VIBES (Coventry): A consortium of academics and industry will create a new electronic system that will be easier to build, as well as being lighter and cheaper.

- BMW (Motorsport) Ltd – FutureBEV (Warwick & Newport): This project aims to deliver better powertrains that are more cost-efficient
- Jaguar Land Rover – ZEUS (Coventry): This project will develop a high-performance four-wheel drive 400kW Fuel Cell Electric Vehicle (FCEV). This project represents a key hydrogen power research project with the aim of developing fuel cell-powered versions of its larger vehicles.

The APC manages the Automotive Transformation Fund (ATF). This fund supports the large-scale industrialisation of an electrified supply chain particularly in the following areas:

- Batteries including cells ('gigafactories')
- Battery management systems
- Electric machines, drives and integrated power electronics
- Fuel cells

Most recently in April 2021, Ricardo headquartered in Warwickshire was awarded funding through the ATF for a feasibility study to quantify the opportunity for niche volume battery pack manufacturing in the UK, including consideration of 'second life' processing

APC also works with SME (Small to Medium Sized Enterprises) with initiatives including the Technology Developer Accelerator Programme and the Niche Vehicle Network – Production Readiness Competition.

R&D and Innovation: MTC

The Manufacturing Technology Centre

The MTC is part of the High Value Manufacturing Catapult established by Innovate UK, the UK's innovation agency and is located in Ansty, Coventry.

The Catapult network supports the commercialisation of research by bringing together industry, government research organisations and universities. The Catapults provide access to state-of-the-art facilities for prototyping, testing and scaling-up of new products and processes. The MTC has notable expertise in: additive manufacturing; digital manufacturing and robotics and autonomous systems.

In early 2021, MTC's robotics experts developed an industrial robot with the decision-making capability of a human operator. Using machine learning and visual recognition, the robot was taught to make assembly decisions based on the components put in front of it.

WM5G in partnership with the MTC is installing a purpose-built private 5G network testbed. This will enable manufacturers to explore the benefits from multi-edge computing and wireless connectivity in digital manufacturing and robotics.

The National Centre for Additive Manufacturing

The MTC hosts the National Centre for Additive Manufacturing. This centre has state-of-the-art 3D printing equipment and was the first R&D centre in the UK to install precision equipment to allow 3D printing of small and complex electronic components

The new equipment enables the production of small-scale electronic components used in smart connected devices, as well as multi-layer printed circuit boards and sensors. Other equipment includes polymer additive manufacturing equipment with a Carbon M2 printer powered by the Carbon Digital Light Synthesis process. MTC is a certified carbon production network partner.

These facilities combined with the expertise of the staff based at MTC enables manufacturers to undertake small runs of products for niche applications or for demonstrating a proof of concept.

The MTCC is working on a significant project (Daedalus) funded by UK Research & Innovation to transform the use of additive manufacturing in highly regulated industries such as aerospace, space and medical devices by developing standards for part quality, reliability, traceability and process repeatability. When these standards are adopted, this will make the Centre a key collaborative partner for manufacturers working in these highly regulated industries.

Supporting Industry to Optimise the Manufacturing Process

MTC's digital manufacturing and autonomous systems capabilities includes supporting companies establishing new manufacturing plants so as to optimise their factory layout and supporting manufacturers to enhance and automate their manufacturing processes. A recent example includes support provided to Albert Jagger, a component manufacturer to re-shore a number of its products back to its Walsall site. Albert Jagger manufactures products such as fasteners, lighting and electrical fittings for industries including automotive, defence and rail.

The MTC worked with the company to optimise its factory layout and introduce new automation technologies into the workshop. This resulted in Albert Jagger being able to produce the product range for 20% - 50% less than the cost of purchasing from overseas as well as increasing supply chain security.

R&D and Innovation: HORIBA MIRA

HORIBA MIRA

HORIBA MIRA and Mira Technology Park is a global Centre of Excellence pioneering engineering, research and test services for the automotive, defence, aerospace and rail industry. The site has IT networks that are fully accredited by the UK Ministry of Defence.

HORIBA MIRA, headquartered in Nuneaton is a transport systems integrator, providing a wide range of services and expertise; from individual product tests to turnkey engineering design, software engineering, development and build programmes. Capabilities are particularly focused on supporting and collaborating with industry to develop the most efficient electric and hybrid vehicles, powertrain and battery systems.

Expertise includes:

- Electrification & Energy
- Powertrain & Emissions
- Certification & Homologation
- Vehicle Resilience (EMC, cybersecurity and functional & safety)
- Safety Systems Engineering
- Connected & Autonomous Vehicles
- Body & Interiors
- Un-manned Ground Vehicles
- Defence

The site provides 40 major test facilities and 100km of specialised proving ground including a military unmanned ground vehicle. This includes approximately 4km of test tracks with various features designed to allow engineers to push these military vehicles to their limits.

Battery Technology and Testing

HORIBA MIRA's comprehensive battery development capability, enables end-to-end engineering and test solutions for cell, modules and complete battery packs. HORIBA MIRA has conducted many environmental and mechanical tests; and full design validation programmes on batteries for automotive OEMs, Tier 1s, defence and other industries using lithium batteries. Development work is currently being undertaken to extend the longevity of battery packs by 40%.

- State-of-the-art facilities includes a new £1.5m battery development facility, featuring a large climatic vibration laboratory and the UK's first battery abuse facility. This is the UK's first facility to offer electrical cycling – enabling battery charging and discharging whilst in use. A range of regulatory testing such as UN ECE Reg. 38.3, Reg 100 and Reg 10 (EMC) can be undertaken on site.
- The Battery Abuse Test provides abuse and safety testing at cell, module and pack level, in all-weather conditions, supported by high-speed cameras, thermal imaging and gas detection.

R&D and Innovation: HORIBA MIRA cont.

Powertrain & Emissions

The vehicle and powertrain test and development facilities include:

- The Advanced Propulsion Test and Development Centre offers the latest emissions measurement equipment, environmental emulation hardware and test automation capability.
- Vehicle Exhaust Emissions Laboratory
- Powertrain Calibration, Powertrain Benchmarking and state of the art EiL system allows frontloading of real-world scenarios to ensure compliance with emissions regulations before prototype vehicles are available.

Software & Controls

HORIBA MIRA creates bespoke software solutions for EV controls or battery management systems for passenger vehicles, defence and electric buses.

Automotive Cyber Security

The Circuit Facility and other Proving Ground Facilities allows for the assessment of automotive cybersecurity vulnerabilities in a controlled real-world environment. The Vehicle Resilience Technology Centre includes:

- Connectivity Lab – focusing on RF (Radio Frequency) related activities including cybersecurity and connectivity.
- Systems Lab – 64m2 fully configurable laboratory split over 2 independent levels for cybersecurity penetration testing and advanced connectivity test development.

Connected & Autonomous Vehicles

HORIBA MIRA works with OEMs and their supply chain to define, design, build, test and validate their CAV solutions and achieve high levels of performance through the use of simulated validation, physical tests and the application of the recognised systems engineering framework.

Centre for Connected and Autonomous Automotive Research and ASSURED CAV

Forming the West Midlands Future Mobility Zone, this represents one of the most comprehensive CAV validation ecosystems in the world. It incorporates an on-site network of campus roads complemented by a 300km network of adjacent CAV-enabled public roads equipped with a range of intelligent transport systems enabling real-world road trials.

- The site extends over 350 hectares and provides the latest facilities to support the design, development and testing of self driving technology including:
 - High speed, urban and automated parking CAV-enabled test environments
 - Extensive ADAS robotic targets and supporting junction layouts
 - Private 4G & 5G mobile network and ITS G5
 - Simulation platform for virtual scenario testing

R&D and Innovation: WMG (University of Warwick)

WMG (Warwick Manufacturing Group)

WMG is part of the HVM (High Value Manufacturing) Catapult and is an academic department within the University of Warwick. In early 2021 WMG and the School of Engineering at the University of Warwick were awarded almost £5.3 million from UKRI and the High Value Manufacturing Catapult for a new Winding Centre of Excellence to help UK supply chain companies to manufacture discrete hairpin machine and for a facility focusing on power electronics reliability and failure analysis. WMG works across industries including automotive, aerospace, rail and defence.

Research capabilities include:

- Energy
- Materials & Manufacturing
- Digital Technologies
- Intelligent Vehicles

Energy

This includes battery scale-up; battery systems engineering; cell engineering; characterisation modelling & control; electrochemical materials and power electronics, machines and drives. WMG has a focus on developing the essential powertrain and battery technologies required for advanced hybrid and electric commercial, rail and marine systems. The Electrical Energy Storage Network, hosted by WMG brings experts together from across disciplines and sectors to drive research and innovation to deliver solutions and disrupters

The Energy Innovation Centre

- A national facility for battery R&D - from materials and electrochemistry through to application, integration, and recycling / re-use. The facility supports the testing, development and scale-up of new battery chemistries from concept through to full proven traction batteries.
- RECOVAS is a key project WMG in partnership with EMR (European Metal Recycling), Bentley Motors, BMW and JLR, the Health & Safety Executive, the UK Battery Industrialisation Centre, Autocraft Solutions Group, Connected Energy to repurpose electric car batteries to develop the UK's first commercial scale recycling facility for automotive battery packs. This project aims to provide a standardised and reliable route for recycling and repurposing lithium-ion car batteries at a scale that can cope with the expected sales of EVs in the UK. EMR is one of the world's leading metal recyclers and has a major site in Oldbury.

Materials & Manufacturing

- Research expertise include: high volume automotive composite manufacturing, nano composites, digital lifecycle management. WMG's Centre for Imaging, Metrology and Additive Technologies (CIMAT) provides a hub for innovation and research in this field.
- The Automotive Composites Research Centre includes composite manufacturing equipment to enable research into process development and demonstration of all stages of the automated manufacturing process. There is also a dedicated composite testing and characterisation facilities. WMG is partner in the UK Composites Innovation Cluster and are involved in multi-partner projects with companies including Jaguar Land Rover, Ford and Aston Martin.
- The Lightweight Technologies Centre of Excellence designs and manufactures the next generation of lightweight solutions, working with other transport sector partners to exploit cross-industry opportunities.

R&D and Innovation: WMG cont.

Digital Technologies

Research activities include automated design and process optimisation and computer vision as well as:

Automation

- Digitalisation and Industry 4.0
- Automation and robotic systems lifecycle engineering (including specification, design, integration, implementation, support and reconfiguration)
- Virtual process planning and virtual commissioning
- Industrial IoT and distributed controls systems
- Digital twin / digital shadow creation and integration
- IT/OT Integration strategies and manufacturing data models
- Production data analytics and information visualisation

Visualisation – focus on:

- High-Dynamic-Range (HDR) technology to enable the creation of complex virtual environments including visual, aural, smell, touch and even taste to achieve a level of perceptual realism. These technologies that for example cars can be designed digitally without the need to build physical prototypes

Artificial Intelligence

- WMG is working on the development of AI technologies to provide machines with fully automated strategies for complex interaction tasks. Other research in this area includes advanced simulations and “digital twins” to optimise physical systems and their control algorithms at the design stage, whether in the automotive industry or industrial robotics.

Intelligent Vehicles

WMG is Centre of Excellence for Connected and Autonomous Vehicle research. Expertise includes cooperative driving systems, connectivity, human factors and verification and validation. Examples of research includes the Safety Pool™ Scenario Database:

- In March 2021, WMG and Deepen AI (a Silicon Valley based start-up) launched the Safety Pool™ Scenario Database, the largest public repository of scenarios for testing autonomous vehicles in e world. This built on the work with the Centre for Connected and Autonomous Vehicles and the UK funded West Midlands Future Mobility Area, which offers a real-world ecosystem for development and trialling of Connected and Automated Technology as part of the Zenzic coordinated CAM Testbed UK capability.

R&D and Innovation: University of Birmingham

University of Birmingham

The University has considerable R&D expertise in rail, automotive, aerospace, energy and other industries. As well as dedicated automotive centres, multi-disciplinary research institutes such as Birmingham Energy Institute also undertake R&D in relation to the automotive industry. The latter is examining how vehicle batteries that have served their purpose in electric vehicles can be used to provide grid storage and services.

Centre for Hydrogen & Fuel Cell Research

- A nationally and internationally recognised centre for expertise in fuel cells with a focus on R&D applications and demonstrations of fuel cell and hydrogen systems and technologies.
- The University of Birmingham is a key partner in a £54m UK collaboration programme (H2GEAR), led by GKN Aerospace to develop the company's first hydrogen propulsion system for sub-regional aircraft.

The Birmingham Centre for Strategic Elements and Critical Materials

- This includes the Faraday Institution Recycling of Lithium Ion Batteries (ReLiB) project in how spent lithium batteries can be recycled. The University has a battery testing and storage facility which is one of only a handful of European Council for Automotive R&D – EUCAR 7 rated centres in the UK so that impact, fire, and explosive battery failures can all be studied safely.

The Magnetic Materials Group

- This is the UK's only research group focussed on processing and recycling of permanent rare earth magnetic materials. Rare earth magnets play a vital role in the aerospace, robotics, electronic, wind turbine, medical, military and automotive industries.

High Temperature Research Centre & Rolls-Royce UTC

- The HTRC is a joint collaboration between the University of Birmingham and Rolls-Royce to enable production-scale research and experimentation. The Centre provides a unique casting, design, simulation and advanced manufacturing research facility
- The University is home to the Rolls-Royce University Technology Centre specialising in materials.

The Vehicle Technology Research Centre, School of Mechanical Engineering

- This research centre has a world leading research profile in combustion engines and low carbon vehicle technology. The Centre's Future Power Systems Group researches new combustion and energy conversion technologies, alternative fuels and hydrogen.
- The Centre's laboratory is supported by industrial partners Jaguar Land Rover, Ford, Johnson Matthey and Shell. The facilities include 7 test beds, 2 single cylinder research and prototype engines,
- The Vehicle Dynamics Laboratory provides a number of key facilities to support research and consultancy activities in the area of vehicle dynamics.

R&D and Innovation: University of Birmingham cont.

The Electrical Power and Control Systems Group (electronic, electrical & systems engine)

Research areas includes:

- Advanced control methods and decision-making tools for infrastructures such as energy systems, technological processes, defence systems and telecommunication systems.
- Operation, control and planning of power grids and smart grids and power system stability and control.

Communications & Sensing Group

This group has expertise in wireless and space-ready communications; virtual and augmented reality; and remote sensing applications.

Areas of research activity includes:

- Emerging Device Technology - interests are based around the theme of microwave materials, devices and systems.
- Antennas and Applied Electromagnetics Laboratory (AAEL) – a key research laboratory embedded in one of the UK's largest and most active research groups in the area of Radio Frequency and Microwave Engineering, with expertise including remote sensing technologies.
- Human Interface Technologies - this research team is pioneering the development, evaluation and uptake of Virtual Reality and telepresence/ telerobotic technologies, with over 30 years of experience in simulation, robotics and Human Factors for applications in aerospace, defence and healthcare.

The National Centre for Nuclear Robotics (NCNR)

The university has considerable robotics expertise and is now developing state-of-the-art robotics, sensing and AI technologies for hazardous environments. The Extreme Robotics Lab is Europe's most prominent university lab dedicated to robotics for nuclear and other extreme environments.

Birmingham Centre for Cyber Security & Privacy

The Birmingham Centre for Cyber Security and Privacy is a recognised Academic Centre of Excellence in Cyber Security Research (ACE-CSR). The Centre has specific expertise in areas including: Industrial Control Systems; Automotive Security with commercial collaborations include with ZF Automotive and Jaguar Land Rover. The University has cyber specialisms in power grids.

The UK Quantum Technology Hub – Sensors and Timing

The UK Quantum Technology Hub Sensors and Timing (led by the University of Birmingham) is one of 4Hubs within the UK's National Quantum Technologies Programme. The latter has over 100 projects, valued at approximately £100m and 17 patent applications. The Hub works across industries including: energy, transport, space and defence. In the latter, research includes in distributed radar systems to enable the detection of stealth objects.

R&D and Innovation: Coventry University

Coventry University

The Institute for Future Transport and Cities (IFTC) coordinates expertise across manufacturing, engineering, design, intelligent systems and business studies with research covers automotive, aerospace, maritime and rail transport.

Coventry University has considerable expertise in autonomous vehicles, and works in partnership with HORIBA MIRA at the Centre for Connected and Autonomous Automotive Research at the MIRA Technology Park.

The School of Mechanical, Aerospace and Automotive Engineering is conducting large-scale research into next generation flight deck technologies. The business-focused outlook of the institution's research has fostered core industry partnerships with leading organisations, including BAE Systems, Rolls Royce, Emirates, Airbus and Birmingham Airport.

Other centres of excellence include:

The Institute for Advanced Manufacturing and Engineering (AME)

AME is a collaboration between Coventry University and Unipart Manufacturing Group which brings together academia, industry and R&D in a 'live' manufacturing environment. The Institute works on developing powertrain-related technologies for automotive, aerospace, rail and renewables.

Facilities on-site include a Metrology Laboratory with both contact and optical dimensional measuring equipment and a visual component placing technology.

The Institute for Advanced Manufacturing and Engineering (AME)

AME is a collaboration between Coventry University and Unipart Manufacturing Group which brings together academia, industry and R&D in a 'live' manufacturing environment. The Institute works on developing powertrain-related technologies for automotive, aerospace, rail and renewables.

Facilities include:

- A multi-station digital manufacturing demonstration line
- Metrology laboratory with both contact and optical dimensional measuring equipment
- Visual component placing technology
- 8-axis robotic welding station
- Robotic laser welding station
- Electrical discharge machining station
- Tensile testing equipment
- Robots, including cobots, for research and teaching
- Sample preparation and inspection laboratory



R&D and Innovation: Coventry University cont.

Centre for Advanced Low Carbon Propulsion Systems (C-ALPS)

This £50m research centre works with the propulsion system supply chain with research areas including: electro-chemical energy storage; hydrogen fuel cells; power electronics and electric machines. C-ALPS is a collaboration between global engineering specialist, FEV Group.

C-ALPS is the most advanced test facility of its kind in the UK. This unique 40,000 sq. ft research and test centre incorporates:

- Battery test facilities
- Prototype cylindrical and pouch battery, supercapacitor cell prototyping line and materials laboratory
- Electronics lab and power-semiconductor characterisation facility
- Hydrogen research laboratory and vehicle workshops
- Expertise and advice on commercialising research and development activity
- EMC chamber
- E-machines test bench
- Independent facility able to work with multiple OEMs, tier 1s and SMEs

National Transport Design Centre (NTDC)

The 1800 m² NTDC is equipped with state-of-the-art facilities and equipment, including: a driving simulator (driver in the loop); Precision CNC milling machines for scale model creation and a range of 3D printing technologies.

R&D and Innovation: University of Wolverhampton

The University of Wolverhampton

The University's key research centres and groups include the Additive Manufacturing of Functional Materials Research group and the Centre for Engineering Innovation and Research which has specific programmes supporting the automotive industry.

A number of the university's research centres are included below:

Centre for Engineering Innovation and Research

This Centre focuses on the development of innovative technologies through application of aspects of material science, engineering to the realisation of tangible and virtual systems or system parts. This includes applications in design, visualisation, simulation and control. The Centre also undertakes research into the design and development of lightweight materials for automotive applications. Its work includes materials development, energy storage and research into advanced manufacturing engineering.

Additive Manufacturing of Functional Materials Research Group

The group's research is focused on enabling future digital fabrication to combine additive manufacturing, materials, and structures to achieve unprecedented mechanical, acoustic, thermal, and electrical properties.

Composite & Additive Layer Materials Engineering Research & Innovation Centre

This Centre is located at the School of Engineering Innovation Campus in Telford. The Centre supports small to medium sized businesses to develop high performance components that are lightweight and make efficient use of materials – particularly for industries including automotive, motorsports, aerospace and wind energy supply chains.

Morgan Motor Company Collaborative Partnership

In March 2021, the University of Wolverhampton signed a new five-year partnership agreement with the Morgan Motor Company. This will include support in development work to convert two Morgan Plus Four models from road-going cars into fully prepared racing vehicles.

R&D and Innovation: Aston University

Aston University

The College of Engineering and Physical Sciences has two internally significant research institutes. These are the Aston Institute of Photonic Technologies (AIPT) – one of the world's leading photonics research centres and the Energy and Bioproducts Research Institute.

Aston Institute of Photonic Technologies

The AIPT coordinates more than 60 national and international, research and industrial projects across science and engineering including:

- High-speed optical fibre system data transmission systems, 5G/6G wireless links, and optical signal processing
- Device technologies such as fibre gratings, optoelectronics, nonlinear photonics, and fibre lasers
- Material processing, including UV and femtosecond lasers, THz technology and nano-photonics.

The Energy and Bioproducts Research Institute (EBRI)

The EBRI focuses on overcoming the engineering and logistical challenges of realising a net-zero future. Expertise relevant to the automotive industry includes Fuel Cells & Hydrogen and applications for power, heat and transport Vehicle-to-Grid Power and Energy Systems.

EBRI has invested heavily in Vehicle-to-Grid power delivery and provides campus wide demonstration of vehicle and control technology. In 2016, Grid Edge, an Aston University AI-tech spin-out, as part of the VIGIL consortium (Aston University, ByteSnap Design, Grid Edge and Nortech Management) launched Britain's first comprehensive communication and control platform for V2G charging systems.

The university has a number of state-of-the-art facilities and labs including :

- **Electronic and Electrical Engineering:** “maker lab” which allows for project work with five 3D printers, circuit prototyping and a laser cutter.
- **Mechanical Engineering and Design:** model shop with:
 - Maker space (four additional 3D printers)
 - Five 3D printers
 - Laser cutting
 - Silicone moulding
 - Vacuum forming and foam cutting facilities

There is also a Design Studio providing interactive space and facilities including: Clay modelling facilities for automotive design; CNC Machine Shop & plasma cutting facility and a materials characterisation suite with advanced cyclic multi-axial testing equipment.

R&D and Innovation: Birmingham City University

Birmingham City University

The Centre for Engineering within the School of Engineering and the Built Environment consists of a number of research groups including the Advanced Materials Manufacturing Research Group and the Sensors and Control Group.

The Sensors and Control Research group

The group works on applied research employing leading edge digital sensor and communication technologies. Areas of expertise include:

- Sensor and embedded digital systems
- Wireless sensing technologies
- Energy harvesting and power management
- Low power electronic and communication

The Smart Sensing & Communication Research Group

This group is working on 'The Internet of Things for Smart Water Innovative Network' (IoT4Win) project which utilises smart sensors, IoT, big data and AI technologies to solve several water use challenges, including providing real-time updates on the quality, quantity and demand for water as well as cyber-physical security for water systems.

The Computational Modelling Research Group

This group's research includes: investigating nano-fluid heat transfer, vehicle aerodynamics, complex systems and hydrological modelling.

The Advanced Materials and Manufacturing research group

This research group consists of three areas:

- Materials: Processing and Design (interaction of complex physical processes in manufacturing and metal forming processes)
- Engineering Systems and Design; Logistics and Supply Chain Management (sustainability, and emerging technologies including robotic and haptics).
- Structural integrity (application of sustainable materials in engineering structures, behaviour of engineering material under low-cycle fatigue)

The Magnesium Innovation Group develops sustainable aerospace uses for magnesium which deliver fuel efficiency through weight savings. The organisation has an exclusive partnership with Meridian Lightweight Technologies UK; the world's largest producer of magnesium components.

Supporting industry to reduce tool replacement and downtime

The Materials Group recently worked on a Knowledge Transfer Partnership (KTP) project with Birmingham-based company C Brandauer & Co - one of the largest contract presswork and stampings companies in Europe reducing tool wear. The estimation of tool wear was important for C Brandauer in scheduling tool changes and for process control and optimisation.

Outcomes of the project demonstrated that the project had a significant positive impact on the operations of the company such as reduction in maintenance cost and time by almost 26%



Skills & Talent

Sector Strengths: Advanced Manufacturing & Automotive

Employment

There are 211,500 people employed in manufacturing as a whole in the West Midlands¹ - representing 11.3% of total employment. This proportion of manufacturing employment is significantly higher than the national average of 7.9%.

With 46,500 people employed in the manufacture of motor vehicles/trailers/semi trailers, this provides a considerable base of experienced labour that employers can draw from. This represents 2.5% of the local workforce compared to the 0.5% for England as a whole. Additionally, the automotive supply chain is represented across a number of other sub-sectors including metals and plastics.

As well as the high proportion of people employed in the automotive industry, there are higher proportions employed in several other areas of manufacturing sectors **locally** than is the case nationally, including:

- Manufacture of fabricated metal (1.9% compared to 0.9%)
- Manufacture of machinery and equipment (1.3% compared to 0.6%)

There are also over 32,000 people employed in computer programming activities locally and over 26,000 employed in engineering activities and related technical consultancy.

With its notable advanced manufacturing base ranging from materials to machinery manufacturing, the West Midlands represents an ideal location for a range of activities including electronics, tooling, automotive related software development, engineering design and R&D.

Number of Employees & Proportion of Employment by Selected Manufacturing Sub-Sectors, West Midlands' LEPs and Comparators, 2019
(Source: Business Register Employment Survey, ONS)

Selected Manufacturing & Computer Programming Sub-Sectors by Standard Industrial Classification	Black Country		Coventry & Warwickshire		Greater B'ham & Solihull		Combined 3 LEPs		West Midlands	England
	No of Employees	%	No of Employees	%	No of Employees	%	No of Employees	%	%	%
22 : Manufacture of rubber and plastic products	4,000	0.9	3,250	0.7	6,000	0.6	13,250	0.7	0.8	0.5
23 : Manufacture of other non-metallic mineral products	1,500	0.3	1,625	0.3	3,250	0.3	6,375	0.3	0.5	0.3
24 : Manufacture of basic metals	7,000	1.6	700	0.2	3,000	0.3	10,700	0.6	0.6	0.2
25 : Manufacture of fabricated metal products, except machinery and equipment	17,500	3.9	7,000	1.5	12,000	1.2	36,500	1.9	1.9	0.9
26 : Manufacture of computer, electronic and optical products	400	0.1	900	0.2	1,625	0.2	2,925	0.2	0.2	0.4
27 : Manufacture of electrical equipment	800	0.2	1,250	0.3	1,500	0.2	3,550	0.2	0.2	0.2
28 : Manufacture of machinery and equipment n.e.c.	6,500	1.5	5,500	1.2	11,500	1.2	23,500	1.3	1.3	0.6
29 : Manufacture of motor vehicles, trailers and semi-trailers	3,000	0.7	21,500	4.6	22,000	2.3	46,500	2.5	2.0	0.5
30 : Manufacture of other transport equipment	1,625	0.4	1,625	0.3	1,000	0.1	4,250	0.2	0.3	0.4
32 : Other manufacturing	1,250	0.3	900	0.2	4,500	0.5	6,650	0.4	0.3	0.3
33 : Repair and installation of machinery and equipment	3,250	0.7	1,750	0.4	4,750	0.5	9,750	0.5	0.5	0.4
62 : Computer programming, consultancy and related activities	3,750	0.8	11,000	2.4	17,500	1.8	32,250	1.7	1.7	2.6
72 : Scientific R&D	200	0.0	2,750	0.6	2,125	0.2	5,075	0.3	0.3	0.5
7112 : Engineering activities & related technical consultancy	3,250	0.7	9,000	1.9	14,000	1.5	26,250	1.4	1.3	1.4
7120 : Technical testing & analysis	200	0.0	700	0.1	1,250	0.1	2,150	0.1	0.1	0.2

¹: West Midlands combined 3 LEP geography

Numbers and proportions employed in Advanced Manufacturing (by selected 2 digit SIC code) Source: BRES 2019 (latest data)

Sector Strengths: Advanced Manufacturing

Employment

Data at a more detailed 3 and 4 digit SIC code indicates the importance of motor vehicle manufacturing. A total of 29,200 are employed in the manufacture of motor vehicles alone. This represents 1.6% of the WM workforce, significantly higher than the national proportion (0.3%). In addition nearly 16,000 work in the manufacture of parts and accessories for motor vehicles.

3,000 work in the aerospace sector of manufacture of air and spacecraft and related machinery, 0.2% of the WM workforce.

In land transport, the bulk of employees work in road freight. 3,750 (0.2% of the workforce) work specifically in passenger rail transport.

Numbers and proportions employed in Advanced Manufacturing (by selected 3/4 digit SIC code)

	Black Country		Coventry & Warwickshire		Greater B'ham & Solihull		Combined 3 LEPs		West Midlands		England	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
291 : Manufacture of motor vehicles	200	0.0	16,000	3.4	13,000	1.4	29,200	1.6		1.2		0.3
292 : Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semitrailers	500	0.1	300	0.1	500	0.1	1,300	0.1		0.1		0.1
293 : Manufacture of parts and accessories for motor vehicles	2,375	0.5	5,000	1.1	8,500	0.9	15,875	0.8		0.8		0.2
301 : Building of ships and boats	0	0.0	0	0.0	100	0.0	100	0.0		0.0		0.1
302 : Manufacture of railway locomotives and rolling stock	0	0.0	300	0.1	100	0.0	400	0.0		0.0		0.0
303 : Manufacture of air and spacecraft and related machinery	1,375	0.3	1,125	0.2	500	0.1	3,000	0.2		0.2		0.3
304 : Manufacture of military fighting vehicles	0	0.0	100	0.0	0	0.0	100	0.0		0.0		0.0
309 : Manufacture of transport equipment n.e.c.	300	0.1	100	0.0	400	0.0	800	0.0		0.0		0.0
491 : Passenger rail transport, interurban	700	0.2	300	0.1	2,750	0.3	3,750	0.2		0.2		0.2
492 : Freight rail transport	0	0.0	0	0.0	400	0.0	400	0.0		0.0		0.0
493 : Other passenger land transport	4,000	0.9	1,750	0.4	6,500	0.7	12,250	0.7		0.6		0.8
494 : Freight transport by road and removal services	7,500	1.7	7,500	1.6	10,000	1.0	25,000	1.3		1.4		1.0
7112 : Engineering activities and related technical consultancy	3,250	0.7	9,000	1.9	14,000	1.5	26,250	1.4		1.3		1.4
7120 : Technical testing and analysis	200	0.0	700	0.1	1,250	0.1	2,150	0.1		0.1		0.2

Source: BRES 2019 (latest data)

Training & Skills Provision: A Strong Talent Pipeline

Further Education and Apprenticeship Training Provision

A range of opportunities exist for learning and development, all helping to support the skilled workforce of the future. There are a number of colleges in the area which offer courses specifically designed to develop and enhance skills in engineering, automotive, aerospace, rail and other disciplines. A selection is included in these following pages.

The Automotive Skills Plan, led by the West Midlands Combined Authority (WMCA), ensures the region's skills base complements the sector and the WMCA works with the automotive supply chain to ensure local talent is both upskilled and reskilled to reflect the future needs of the industry.

MIRA Technology Institute (MTI):

MTI, located at MIRA Technology Park provides training specifically related to the automotive industry. The institute is a partnership led by North Warwickshire and South Leicestershire College, HORIBA MIRA, Coventry University and two other universities. The curriculum is aimed at providing the specialist skills required by the automotive sector, focussing particularly on disruptive technologies such as electrification & autonomous cars.

MIT provides a number of learner pathways including apprenticeships ranging from Level 2 apprenticeships in Autocare Technician through to higher and degree level apprenticeships leading to engineer status. There are undergraduate and postgraduate courses in engineering with specialist areas including product design and development. MTI works closely with employers enabling curriculum to be flexible enough to adapt to specific industry and business needs.

Students have access to a range of new, disruptive technologies as part of their courses including Rapid Prototype, 3D Printing, Robotics, Fluid Power, Mechatronics and Electronic Circuit Design.

MTC Training:

The MTC at Ansty Park in Coventry specialises in training in digital manufacturing, additive manufacturing, automation and robotics as well as intelligent automation.

- The MTC delivers an Advanced Apprenticeship programme. Through their partnership with Lloyds Bank, the programme benefits from a £1million annual fund to deliver high-value engineering apprenticeships to Small to Medium sized businesses.
- The Centre offers a range of short courses at different levels including for instance in additive manufacturing where courses include a short intensive course on Design for Metal Powder Bed Fusion or a foundation certificate in additive manufacturing.

Make UK Technology Hub & Apprenticeship Training

The Make UK Technology Hub, located in Aston, Birmingham, is a skills development and training centre for apprentices and professionals in manufacturing and engineering.

- The Hub provides state of the art training facilities, equipped with the latest manufacturing equipment to train the next generation. Offering a variety of apprenticeship pathways in manufacturing and engineering from level two upwards.
- Training courses available to upskill the current workforce through both structured and bespoke programmes in all areas of Manufacturing and Engineering. It is currently the only centre in the UK offering the level 3 qualification in Robotics and Automation.

Training & Skills Provision: A Strong Talent Pipeline cont.

The West Midlands Group Academy for Young Engineers

The West Midlands Group Academy for Young Engineers in Coventry and Solihull is a specialist 16-18 year old's college for science, technology, engineering and maths. The academy works with employers such as Aston Martin, Jaguar Land Rover, National Grid, Arup and Balfour Beatty.

The National Apprenticeship Centre, Birmingham

The Centre offers a wide range of apprenticeships including: Lean Manufacturing Operations, Improvement Technician, Supply Chain Logistics Operative.

The Elite Centre for Manufacturing Skills

The Elite Centre for Manufacturing Skills (ECMS) is an employer-led training facility located in the Black Country, designed to support the UK industry in upskilling and multi-skilling the workforce, with a particular focus on developing technical skills and knowledge in engineering, manufacturing, casting and metal forming industries.

Coventry College

Coventry College offers courses from entry-level qualifications, through to degree-level and specialist professional courses. It delivers courses in Engineering and Automotive at varying levels such as level 1 performing engineering to level 3 diploma in engineering. The college also has an automotive apprenticeship training programme as well as a cyber security apprenticeship.

South and City College Birmingham

South & City College South and City College Birmingham has recently launched Centre of Excellence for Engineering provides students with industry-standard equipment and software, and lecture theatres with interactive tech. Courses range from engineering BTEC Level 1 to Advanced Apprenticeship Engineering Technician (Machinist Pathway) Level 3 and a Level 5 Foundation Degree in Electrical and Electronic Engineering (Awarded by UCB & in partnership with the University of Birmingham).

Solihull College & University Centre

Solihull College & University Centre is an FE College which has strengths in engineering disciplines including automotive. They offer a range of courses including Level 3, apprenticeships and Higher Education. Facilities include world-class flight simulators and a former Royal Navy Aircraft at their Woodlands Campus. Their motor vehicle facilities allow students to train with new electric and hybrid vehicle and driverless technologies.

The college is the lead organisation for the **Greater Birmingham Institute of Technology** – a collaboration between 4 universities and 3 FE colleges in Birmingham and Solihull. The recently opened Institute of Technology provides higher level technical skills (levels 4 and 5), including a digital T-Level in September 2021. Employer stakeholders include Bosch Thermotechnology Ltd, Salts Healthcare Ltd, Alucast, Continental Engineering Services and HydraForce programme.

Training & Skills Provision: A Strong Talent Pipeline cont.

Sandwell College

Sandwell College is home to over 5,000 students has automotive engineering courses housed in a specialist automotive centre.

Dudley College of Technology

Dudley College of Technology is a Further and Higher Education college which offers a range of courses including Level 2, 3 and higher apprenticeships in engineering. They have recently announced plans for the creation of the £32.5 million Black Country & Marches Institute of Technology specialising in advanced engineering and manufacturing, modern construction methodologies and medical engineering. The curriculum will include high-quality technical education programmes from Level 4 to degree level.

National College for Advanced Transport & Infrastructure (NCATI)

The National College for Advanced Transport & Infrastructure is located on a state-of-the-art campuses in Birmingham and Doncaster. NCATI is dedicated to providing the higher-level training required to create HS2, Northern Powerhouse Rail and other rail projects, as well as supporting the skills demand from employers who are facing skills challenges such as digitalisation of the railway and an ageing workforce.

- The College provides technical and professional courses, using the very latest industry technology, to a diverse range of learners that are starting a career in the industry, are looking to switch careers, or are part of the existing workforce.
- It offers a range of courses including apprenticeships and foundation degrees all specialising in high-speed rail and infrastructure

Walsall College:

Walsall College has a state of the art Digital Engineering Centre which includes workshops, classrooms and technology suites, providing training for careers in engineering, welding, fabrication, Performing Engineering Operations (PEO) and civil engineering. Workshops include a CAD-CAM (Computer-Aided Design and Machining); BIM (Building Information Modelling) and CNC Milling workshops as well as a Mechatronics Lab which where students can perform a comprehensive range of PLC programming tasks through a combination of computer and device programming.

Aston University Engineering Academy:

Aston University Engineering Academy is a specialist engineering university technical college catering for students aged between 14-19. Business partners of Aston University Engineering Academy include E.ON, Goodrich Corporation, National Grid plc, PTC and the Royal Air Force and Network Rail.

There are numerous other FE colleges across the combined LEP geography of the West Midlands which offer courses of relevance to advanced manufacturing and automotive specialisms, These include City of Wolverhampton College, Halesowen College and BMet College. The latter offers over 30 different sector based apprenticeships, from Level 2 to University level.

Training & Skills Provision: Universities

Higher Education Provision

There are over 385,000 students studying at numerous universities within an hour's drivetime. 14 of the 22 universities within an hour's drivetime have been awarded the highest 'gold' award in the Teaching Excellence Framework (TEF) which assesses the standard and quality of teaching in undergraduate study across universities and colleges in the UK.

Students in relevant subjects

There is a significant number of students studying relevant subjects at universities in the catchment area – for instance, for the academic year 2019/2020 there were 32,570 student enrolments in engineering and technology related subjects.

HE student enrolments by HE provider (total within c1hour drive time) and subject of study 2019/2020

Selected Subject	No. of Students
Physical sciences	10,515
General and others in sciences	310
Mathematical sciences	6,915
Engineering and technology	32,570
Computing	19,450
Geographical and environmental studies (natural sciences)	3,260

Source: Higher Education Statistics Authority (HESA)

High Levels of Graduate Retention

The West Midlands is ranked 3rd of all the English regions in terms of graduate retention. 55% of graduates remain in the West Midlands compared to 47% in the South-East. In relation to domiciled students, 68% stay in the West Midlands compared to 57% in the South-West and 63% in the South-East

University	HE Student Enrolments by HE Provider 2019/2020	TEF rating: 2019
Aston University	15,385	Gold
Birmingham City University	26,930	Silver
University of Birmingham	35,760	Gold
University College Birmingham	4,930	Silver
Newman University	2,795	Silver
Coventry University	38,450	Gold
University of Warwick	26,825	Silver
University of Wolverhampton	18,875	Silver
Harper Adams University	4,680	Gold
University of Keele	10,880	Gold
Staffordshire University	15,675	Gold
University of Worcester	10,180	Silver
Bishop Grosseteste University	2,285	Gold
De Montfort University	29,000	Gold
University of Derby	19,675	Gold
The University of Leicester	16,185	Silver
The University of Lincoln	16,415	Gold
Loughborough University	18,300	Gold
University of Nottingham	34,840	Gold
The Nottingham Trent University	35,800	Gold
University of Gloucestershire	7,910	Silver
The University of Northampton	12,065	Gold
Total	385,125	

Source: Higher Education Statistics Agency (HESA) 2019/2020

Training & Skills Provision: Universities

Aston University

Aston University offers a wide range of engineering degrees including specialisms in design, electrical and electronic and an embedded electronic systems design and development BEng degree apprenticeship.

The university's strengths in computer science means that it has good cross over study opportunities in the areas of AI and software engineering, with several engineering courses offered as a joint honours with computer science.

At postgraduate level, courses include the MSc Smart Telecom and Sensing Networks (SMARTNET) and the Photonic Integrated Circuits, Sensors and Networks (PIXNET) as well as an MSc in Future Vehicle Technologies and Applied AI MSc. The University also offers a BSc in Cyber Security.

Birmingham City University

The School of Engineering at Birmingham City University offers engineering undergraduate degrees (BEng and MEng) in areas such as electronic engineering, manufacturing engineering and automotive engineering which is also available as a post graduate taught MSc.

Other postgraduate courses include MScs in Artificial Intelligence and Big Data Analytics. There is also an Engineering Research Degree PhD programme.

Coventry University

Relevant undergraduate degrees at Coventry University include Aerospace Systems Engineering, Automotive and Transport Design, Automotive Engineering and Computer Hardware and AI. At postgraduate level MScs available include in MSc in Production Engineering and Operations Management; Connected Autonomous Vehicles; Control, Automation and AI; Digital Technology for engineering and Embedded Systems Engineering.

- Coventry University is home to the National Transport Design Centre which has research specialisms in disruptive transport solutions including connected autonomous vehicles (CAVs), enabling postgraduate students to participate in leading research into this area.
- The University's Cyber Security Group is part of the Institute for Future Transport and Cities. It consists of a team of multi-disciplinary researchers addressing issues of systems security for automotive, rail and connected infrastructure. The Centre also runs a automotive cybersecurity short courses.
- The Institute for Advanced Manufacturing and Engineering (AME) is a collaboration between Coventry University and Unipart Manufacturing Group (UMG). The Institute uses an innovative 'Faculty on the Factory Floor' approach which enables students to work towards either BEng, MEng (Hons) or MSc in Manufacturing Engineering over three, four or a one-year period respectively, with the opportunity to apply for industry internships, company placements and possible employment opportunities with Unipart Manufacturing Group and the wider supply chain.

Training & Skills Provision: Universities

University of Birmingham

The University of Birmingham is a member of the Russell Group and has an extensive range of undergraduate and postgraduate degrees housed within its School of Engineering and Physical Sciences.

- In the newly built £46.5m School of Engineering, undergraduate degrees on offer include: BEng and MEng in subjects including: Aerospace Engineering; Electronic & Electrical; Mechanical Engineering (Automotive); Mechatronic & Robotic Engineering; and Electrical & Railway Engineering.
- Many courses offer an industrial year placement. Postgraduate courses include MSc degrees in Electrical Power Systems and Railways Systems Engineering.
- The University's MSc in Cyber Security is fully certified by GCHQ. The GCHQ scheme is part of the National Cyber Security Strategy to ensure the highest level of quality of teaching.

University of Warwick

The School of Engineering in collaboration in with the Warwick Manufacturing Group (WMG) offers a wide range of engineering degree and degree apprenticeships both at undergraduate and postgraduate taught level.

Undergraduate BEng or MEng courses include in specialisms such as automotive, electronic, manufacturing, systems and computer systems engineering.

Postgraduate courses include MScs in sustainable automotive electrification; smart, connected and autonomous vehicles; electrical power engineering; big data and digital futures engineering, cyber security engineering and communications and information engineering.

The University of Warwick is a ACE-CSR recognised Centre of Excellence and offers a NCSC (National Cyber Security Centre) (NCSC) certified BSc in Cyber Security and a MSc in Cyber Security Engineering.

University of Wolverhampton

The Faculty of Science and Engineering houses the School of Engineering where undergraduate courses include BEng and MEng degrees in different engineering specialisms including Automotive Engineering, Aerospace Engineering, Electronic & Telecommunications Engineering, Mechatronics Engineering and Manufacturing Engineering (BEng only).

Many of these degree courses offer industry year placements. Postgraduate degrees include an MSc in Manufacturing Engineering and an MSc in Advanced Technology Management (engineering analysis).

The Wolverhampton Cyber Research Institute is within the School of Mathematics and Computer Science and offers both a BSc (Hons) and MSc in Cyber Security.

Industry Trends



Trends:

Green Agenda – Climate Change

- The UK government is a global leader on climate change commitments, with an announcement in April 2021 that could see the UK cut carbon dioxide by 78% by 2035 from 1990 levels.
- Transportation accounts for approximately 23% of global energy-related greenhouse gas emissions, and road transport makes up 72% of that, according to the Intergovernmental Panel on Climate Change. Batteries are key to electrification.
- Electrification of the automotive industry is being driven by climate change targets. PwC analysis indicates that EVs may represent approximately 14% global new vehicle sales in Europe and China by 2025. Bloomberg NEF forecast that the 316GW of batteries produced globally in 2019 is anticipated to grow to 1211GW annually by 2025.
- The Faraday Institution 'Battery Demand Forecasting Model (2020) projects that UK EV battery manufacturing capacity in 2040 will be around 140 GWh per year. This implies a very considerable growth in UK battery manufacture with the establishment over the next twenty years of about 7 “gigafactories” in the UK with each producing on average 20 GWh of battery capacity each year.
- At present only 38% of the UK’s railway electrified – electrification of the railway is vital for the UK to meet its target of reaching net-zero carbon emissions by 2050.

Regulatory

- Climate Change targets is leading to governments adopting increasingly stringent emissions limits for light-duty vehicles like passenger cars. The UK government has set-out the phasing out of the sale of new petrol and diesel cars by 2030. Average EU wide fleet targets for new cars will be 5g CO2/km from 2021, mandated to fall a further 37.5% by 2030.

- By 2026 at least 55% of car’s value must be derived from UK/EU or face substantial tariffs. In the EU-UK Trade and Cooperation Agreement (TCA), material produced in both the UK and EU can qualify for it. The UK and the EU agreed that EVs will remain tariff-free until the end of 2023. This is on the condition that at least 40% of their components are of European origin, and at least 55% until the end of 2026.
- Under current EU law and also post- Brexit, manufacturers retain responsibility for the safe disposal of electric car batteries.
- The UK Government is a global leader in developing a supportive regulatory framework to enable the safe development and deployment of CAV technology and plans to allow “self-driving” vehicles on UK roads by the end of 2021,
- The aerospace industry is one of the most strictly regulated industries and concerns regarding power density and efficiency of aircraft electrical systems may act as restraining factors to the overall market growth of electric propulsion systems.
- The introduction of the European Railway Traffic Management System (ERTMS) is mandated by the control, command and signalling TSI (Technical Specification for Interoperability). The system will progressively replace some conventional signalling systems over the next 15 to 20 years with trains instead being controlled by radio signals.

Technological

- Electrification is changing the nature of the automotive supply chain, from mechanical and hydraulic vehicle components to mechatronics technology, comprising mechanical elements, electronics and software such as sensors. The move to electrified cars and more connected vehicles is growing the number of individual control units driving (currently around 100) with the need to centralise car control systems.

Trends:

Technological – Cont.

- A 2019 Reuters analysis of 29 global automakers found that they are planning to spend at least \$30 bn to develop and procure batteries and EVs over the next 5 to 10 years. This being driven by government regulation and rapid technological advances that have improved battery cost, range and charging time.
- The increasing number of automotive sensors (with applications including engine management and vehicle safety) is leading to the forecast that the global automotive sensor market size expected to reach \$39.41bn by 2027 (from \$16.82bn in 2019), with a compound annual growth rate (CAGR) of 10.4% during the forecast period 2020 to 2027. (Global Newswire 2020). Typically automotive sensors include: LIDAR, radar and thermal.
- Continued R&D into battery packs is vital both in terms of how much energy can be stored per unit mass and per unit volumes.
- The global autonomous cars market reached a value of nearly \$818.6bn having increased at a compound annual growth rate (CAGR) of 12.7% since 2015. The market was expected to decline due to the economic impact of COVID-19. However, the market is expected to recover and reach \$1,642.9 bn in 2025. The semi-autonomous cars market was the largest segment of the autonomous cars market segmented by product type, accounting for 97.1% of the total in 2019. (Research & Markets 2020)]
- As technology is evolving, the aerospace industry is starting to developing hybrid and electric propulsion systems for small passenger aircraft while larger aircraft will rely on hybrid electric solution. Battery cells now allow flight times up to an hour, and this time is steadily increasing with continuing innovations in storage energy density. Technology advancements in autonomous and simplified control systems will make it less costly to certify future electric jet pilots.
- Lightweighting technologies are key to the automotive and aerospace industries in their drive to meet new CO2 targets.
- Investment in new technologies is growing in the rail industry – from remote condition monitoring to connected robotic devices. A major focus will be using data and artificial intelligence to monitor tracks and asset optimisation of trains. Technology is also key to safety, particularly in the implementation of automatic train controls.
- Alternative traction options in the rail sector such as battery and hydrogen power are important but cannot replace electrification due to the very energy intensive nature of freight and high-speed services.
- The uptake of robotics in the UK has been mainly adopted by the automotive industry, but the roll-out of 5G is set to increase the adoption of robotics in manufacturing sectors that have only recently turned to automation, such as food processing and plastics. The UK has been slower than other industrialised countries to take-up robotics, with the UK ranking 22nd in terms of robot density (Deloitte 2020). The roll out of 5G as well as the impact of staffing as a result of Covid-19 is likely to create a considerable opportunity for robotic and autonomous systems companies.
- McKinsey estimate that Industry 4.0 will account for sales of about 22 million 5G IoT units in 2030, with most applications related to manufacturing and with other key segments including smart city, smart energy and connected health (The 5G Era, 2020). S
- The Global Industrial Robotics market accounted for \$39.64bn in 2019 and is expected to reach \$101.72bn by 2027 growing at a CAGR of 12.5% during the forecast period. Skills shortages and mitigating the adverse impact of COVID-19 is increasing investment in automated systems. However, high installation cost of industrial robots, especially for small and medium-sized businesses is likely to hamper the market. COVID-19 Impact on Industrial Robotics - Global Market Outlook (2019-2027), ResearchAndMarkets.com.
- The Industrial Internet of Things (IIoT) market is expected to grow \$77.3bn in 2020 to \$110.6bn by 2025 (Markets&Markets2021). The growth of the IIoT industry is being driven by technological advancements in semiconductor and electronic devices; and increased use of cloud computing platforms. The roll-out of 5G networks is set to considerably increase the take-up of IIoT technologies particularly in areas such as condition asset monitoring and predictive maintenance system.

FDI Sector Data

EIM: Leading Sectors

In 2019 the leading sectors generating the largest number of investment projects into the West Midlands were Transportation Manufacturers & Suppliers; Digital and Machinery & Equipment

Transportation manufacturers & suppliers accounted for the highest number of projects in 2019 (12%) – 22% of all projects. This is a significantly higher proportion than for the UK as a whole where just 5% of all projects in 2019 were in this sector.

Machinery & equipment projects were also more pronounced in the West Midlands – these accounted for 10 projects in 2019, 18.5% whereas the proportion for the UK as a whole was 7.1%.

Digital projects into the West Midlands 3 LEP geography area accounted for 9 (16.7%) of all projects in 2019. This is a lower proportion than for the UK as a whole where digital was the sector which accounted for most projects as a whole (39%).

There were 4 Electronics & IT projects into the West Midlands in 2019 – at 7.4% of all projects this is higher than for the UK as a whole (2.8%). In addition, whilst not a ‘leading sector’ there was also 1 ‘electrical products’ project in the same year.

Across all the leading sectors, the number of projects in 2019 was down slightly on 2018. The exception to this was in Finance where after no projects in 2018, there were 3 in 2019.

Looking at key sectors over the last decade, it is notable that investment into machinery & equipment has increased in recent years as well as in digital.

	Total 2010-2019	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2019% WM	2019% UK
Transportation manufacturers & suppliers	140	9	4	8	15	14	27	14	20	13	12	22.2	4.7
Digital (inc. Information, Comms & Media)	71	4	3	4	1	4	6	7	12	12	9	16.7	39.0
Machinery & equipment	59	4	4	1	3	6	6	5	2	15	10	18.5	7.1
Business services	52	4	1	4	2	4	3	12	9	5	3	5.6	10.2
Transportation & logistics	33		2	3	4	2	3	5	9	3	2	3.7	3.4
Metals	30	1	0	4	1	2	10	6	4	0	0	N/A	0.2
Electronics & IT	27	2	1	3	2		1	4	3	5	4	7.4	2.8
Agri-food business	25		2	3	1	4	1	4	4	3	3	5.6	5.0
Chemicals & plastic	23	4	0	0	2	2	2	3	1	2	2	3.7	1.9
Finance	23	2	1	0	2	2	3	6	1	0	3	5.6	8.8
Total projects	583	38	28	36	39	54	76	77	77	64	54		

Source: EYEIM 2020
West Midlands refers to the 3 LEP Geography
Table shows number of projects by leading (and selected) sectors