The automotive sector continues to grow and is Europe’s largest investor in R&D, helping to deliver sustainable motoring for the 21st century. WMG has developed cutting edge research from a diverse range of disciplines and, through partner projects, have integrated these into innovative products that meet both social and consumer needs.

Much has changed in the automotive industry. Driven by demands of energy security and climate change, vehicle powertrains are becoming more efficient but more complex. With increased R&D, hybrid and fully electric vehicles are finding a place in the new vehicle market. This is in many ways the most exciting decade for automotive evolution since the 1920s. In order for a car to compete in the fierce global market it needs to meet not only the changing technological requirements, but also the social needs and demands of the consumer. This creates challenges from fundamental science, such as battery chemistry, through to manufacturing and business processes.

We have been collaborating with the automotive sector for over 30 years, leading major multi-partner projects which have resulted in making cars, and companies, increasingly smarter, lighter and greener. We are continually investing in research which addresses the priority automotive R&D areas identified by the UK Automotive Council, including lightweight structures, electric machines and power electronics, intelligent systems and energy storage and management.

Our National Automotive Innovation Centre, due to open in 2016, will focus on the long term multi-disciplinary R&D challenges of smarter, lighter, greener cars. This collaborative £150m project with Jaguar Land Rover and Tata Motors will deliver a long-term strategic plan, creating a new research base which will enhance the UK’s capacity and capability in key areas of research. The building will be 33,000m² creating the largest automotive R&D facility in the UK, providing innovative design studios, collaborative working space and state-of-the-art research facilities.

The UK automotive sector is spearheading progress in advanced propulsion systems, led by the Automotive Council and the new Advanced Propulsion Centre (APC). The University is delighted to be at the heart of this through hosting the APC Hub on campus from 2014.
Our vision is to deliver high quality interdisciplinary research to achieve global impact in the automotive sector. Our success in leading major multi-partner projects is underpinned by a culture of research excellence, to create impact, for our partner companies and organisations, through the development of new products, services and processes. We achieve this through our internationally leading academics and our state-of-the-art research facilities and infrastructure. To achieve this success our research capabilities are summarised below:

**Powertrain**
- Unique UK facility for battery and energy storage providing
- Battery chemistry development at coin cell level
- Manufacture of automotive representative pouch cells
- Testing at cell and pack level, including electrical, thermal and vibration
- Battery abuse facility to study catastrophic failure through crash or piercing
- Development of automotive electric machines for high volume manufacture
- Development of power electronics for Inverters, DCDC converters and chargers

**Systems Integration**
- Modelling lead approach for definition of powertrain system architectures
- Vehicle control systems including considerations of functional safety
- Thermal modelling of vehicle systems (cooling, HVAC, motor, battery)
- Validation testing using our climatically controlled dynamometers and battery emulators

**Lightweighting and Materials**
- Pioneering the use of aluminium to make the Jaguar XJ/XFF-Type and the new Range Rover lighter by developing forming and joining solutions
- Developing stamp-formed thermoplastic composites which can be made at automotive manufacturing cycle times (>60s per component)
- Targeting 55% weight reduction in composite suspension components
- Use of carbon nanotubes for grain refinement of aluminium alloys to improve porosity, mechanical and fatigue properties, allowing significant component weight reduction
- Incorporating 1D and 2D organic and inorganic nanoparticles in Polymer Nanocomposite Foams to achieve high strength lightweight materials
- Pioneering the use of magnesium to make the Jaguar F-Type and the new Range Rover lighter by developing forming and joining solutions
- Developing stamp-formed thermoplastic composites which can be made at automotive manufacturing cycle times (>60s per component)
- Targeting 55% weight reduction in composite suspension components
- Use of carbon nanotubes for grain refinement of magnesium alloys to improve porosity, mechanical and fatigue properties, allowing significant component weight reduction
- Incorporating 1D and 2D organic and inorganic nanoparticles in Polymer Nanocomposite Foams to achieve high strength lightweight materials
Case Study
Self-Piercing Riveting Feasibility Prediction using Finite Element Analysis

Objective
To simulate the self-piercing riveting process and predict the feasibility of its use on a range of substrates

Sector
Automotive

Collaboration Partners
Jaguar Land Rover

Sponsor
Jaguar Land Rover

Description
This research focused on the feasibility prediction of the Self-Piercing Riveting process (SPR). SPR is the core joining process used by Jaguar Land Rover to assemble lightweight body-in-white structures. This is essentially a cold forming operation that allows the joining of two or more sheets of materials simply through a mechanical interlock.

Even if the process is quite simple, the quality of a SPR joint is a function of several parameters such as rivet design, die geometry, and setting velocity. Currently, the validation of the possible rivet/die combinations within a cell of the body-in-white assembly facility is assessed by extensive experimental tests that consume time and materials.

The objective of the research was to develop a finite element model able to simulate the SPR process and so to reproduce the cross-sectional geometry of the joint. Then, the quality of the joint was assessed by measuring geometric parameters. This enabled faster vehicle design process as more rivet ability assessment was provided.

Case Study
Low Carbon Vehicle Technology Project

Objective
Revolutionise the way low carbon vehicles, including full battery vehicles and hybrid vehicles, are designed and developed in order to significantly reduce carbon emissions

Sector
Automotive

Collaboration Partners
Coventry University, Jaguar Land Rover, Mira, Ricardo, Tata Motors European Technical Centre and Zytek Automotive

Technical Centre and Zytek Automotive

Description
The Low Carbon Vehicle Technology Project (LCVTP), led by WMG, was a major collaboration between leading automotive companies and research partners. It was a £29m funded project, by (the former) Advantage West Midlands, the European Regional Development Fund and contribution from industry partners, bringing together world class UK OEMs, consultancies, suppliers and academic institutions into a focused collaborative programme to create the required R&D capability and capacity for the development of key low and ultra-low carbon vehicle technologies.

The project concentrated on fifteen separate technical R&D workstreams, each working closely with selected SMEs in the West Midlands region.

Our research was focused on HMI, lightweight structures and power electronics.

The project outcomes were:
- Jobs Safeguarded 1943
- Business Assists (including SMEs) 43
- New Business Collaborations 6
- Skills 826
- Value Added £39.76m
- R&D Investment Made £52.33m
- New Products and Processes 51
- and Private Sector Investment Attracted £1.55m.

User Focus
- Development of HMI solutions to improve user experience of low carbon vehicles
- Development of a driving simulator to understand how people interact with new vehicle technology
- Understanding of public acceptance of new technology

Manufacturing and Assembly
- Manufacturing process design and simulation for automotive components (engines, motors, batteries) at high volume production
- Leading a £1.9m project with Ford developing component-based modular reconfigurable manufacturing systems
- Developing Remote Laser Welding for applications in automotive assembly, to reduce costs and improve quality
- Developing metrology techniques to improve process control, reduce measurement times, and deliver data in an intuitive form
- ALM Inconel valve head 25% lighter and with much increased temperature capability

Business
- Leading SME support programme that enables SMEs to develop innovative new products and find new markets – with proven success in automotive sector
- Developing new processes for understanding life cycle emission
- Development of alternative business models (especially digital) and supply chains
- Application of Additive Layer Manufacturing in appropriate circumstances

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WMG was founded by Professor Lord Bhattacharyya in 1980 to help reinvigorate UK manufacturing. From its inception, WMG’s mission has been to improve the competitiveness of organisations through the application of value adding innovation, new technologies and skills deployment, bringing academic rigour to industrial and organisational practice.

Today we are one of the world’s leading research and education groups, with over 500 people working across six buildings on the Warwick campus plus collaborative centres in seven countries. We have an annual programme of £180m which includes industrial and in-kind support. An academic department of the University of Warwick, we are at the forefront of innovative technology, leading major multi-partner projects, with OEMs as well as SMEs, to create and develop exciting new processes, products and services that can lead to major breakthroughs and be of huge benefit to organisations both in the UK and globally.

In 2014 we launched three new R&D centres: the Energy Innovation Centre, the Automotive Composites Research Centre, and the International Institute for Nanocomposites Manufacturing. The National Automotive Innovation Centre will be opening in late 2016.

We pride ourselves in being forward thinking and taking the lead in many areas of research innovation. We understand that in order for companies and organisations to stand out, they need to invest in R&D. Working in collaboration with an internationally renowned university research group gives access to a wealth of expertise. We are always looking for partners to collaborate on world leading new technologies. There are a number of ways in which you can engage with us, including collaborative R&D projects, sponsoring an EngD project, SME engagement through our Innovation Programme, or use of our R&D test facilities.

We have been educating the leaders of tomorrow for over 30 years both in the UK and overseas. We are recognised as a world class centre for delivering postgraduate and executive education. We educate people to understand the bigger picture, encouraging research students and delegates to implement new ways of thinking.

We have two doctoral centres, which offer EngD (International) programmes, in the areas of high value, low environmental impact manufacturing and, sustainable materials and manufacturing respectively.

Our part-time executive programmes have been developed in partnership with engineering, manufacturing, technology and service-led companies. We are experts in creating customised programmes for global companies which deliver educational solutions to meet business needs. The Technical Accreditation Scheme developed for Jaguar Land Rover is an excellent example of what we can offer.

For more information on collaborative opportunities:

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