CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Automotive Capabilities

at Cardiff University

Contents

A world leading University

Cardiff University has an international reputation for excellence in teaching and research, recognised by our membership of the elite Russell Group, the UK's leading 24 research-led universities. Our world-leading research was ranked 5th amongst UK universities in the latest Research Excellence Framework for quality and 2nd for impact. We attract the best students and staff from around the globe and our commitment to deliver research-inspired teaching enables our graduates to be innovative individuals who push the boundaries of their disciplines. Teaching at the University was given the highest possible award in the last UK Government review.

As one of Wales anchor organisations and an institution of enterprise, research and learning, we have a strong track record of collaborative research with industrial partners, including leading vehicle manufacturers.

This document outlines some of the opportunities from across the University that are of direct relevance to the automotive sector. It is by no means exhaustive, but gives a flavour of some of the research and teaching activities undertaken and also potential areas for future collaboration.

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Automotive Related Research

Alongside delivery of Internationally recognised undergraduate and postgraduate programmes, the University is organised into a series of world class research groups which focus on todays most challenging and exciting automotive issues.

Engineering

The High Value Manufacturing (HVM) Group

Based in the School of Engineering the HVM Group conducts word class research across a range of areas including:

- Additive Layer Manufacturing - Wide range of technologies including power bed fusion (selective laser sintering), photo polymerisation (stereolithography), fused deposition modelling and 3D printing.
- Autonomous Systems and Robotics - Industrial robotics, service robotics, robots for medical applications and security, autonomous/semi-autonomous control, human-robot interaction, intelligent navigation, object recognition and human tracking.
- Design & Manufacturing - Digital design, digital manufacturing, computer-aided product, process and system design, manufacturing informatics, digital life cycle management, business process modelling and Industry 4.0.
- Intelligent and Knowledge-based Systems - Data mining, knowledge discovery, image processing, decision and performance support systems, optimisation; pattern recognition, machine learning, semantics, knowledge management and knowledge-based applications.
- Smart Systems - Systems embedded intelligence, smart sensors, intelligent condition monitoring and prognostics, machine and process health management strategies and high speed real time data analytics.
- Systems Engineering - Systems integration, systems modelling, risk assessment and risk management, cyber-physical systems, Internet of things and Industry 4.0.
- Sustainable Manufacturing - Design for sustainability, sustainable manufacturing, resilient and sustainable supply chains, energy efficiency and remanufacturing.
- Renishaw Metrology Laboratory - State of the art measuring equipment.
- Micro/Nano manufacturing - Laser manufacturing, product miniaturisation, future product platforms and production scale up.

Mechanical & Structural Performance Group

The mechanical and structural performance group specialise in the development of advanced materials, structures and non-destructive monitoring techniques. Equipped with world leading facilities, the group conducts cutting-edge research in areas including:

- non-contact dynamic and vibration analysis of structures and machinery,
- composite manufacture and development
- large scale mechanical testing
- non-contact noise finding
- health monitoring of structures and machines

The group have conducted world leading research with industrial collaborators from high-end motorsport, tier one automotive and aerospace companies.

Tribology & Contact Mechanics Group

The Cardiff Tribology Group has an international reputation in the study of elastohydrodynamic lubrication and combines leading numerical analysis capability with a range of complimentary experimental investigations.

This research includes health monitoring of rotating machinery, in particular gear transmissions, and the development of sensitive tools for early failure detection and prognosis. This is based on a range of techniques, primarily Acoustic Emission (AE) monitoring, with an experimental approach married to appropriate simulation tools.

The group also has expertise in development, testing and wear modeling of composite bearing liner materials and the development of micro-textured surfaces for friction reduction.

Centre for Research in Energy, Waste and the Environment

The centre has a long-standing history of research in the combustion of both traditional and alternative fuels, including automotive biofuels, synthetic gas-to-liquid blends and ammonia. Fundamental research has involved the study of GDI spray processes in automotive engines, measurement of droplet breakup, particulate matter generation and safety cases for the use of alternative fuels.

Recent international industrial collaborations have included the development of emissions standards, measurement of the impact of GDI systems and the performance of liquid biofuels under elevated pressure and temperature conditions.

Experimental facilities include cloud chamber rigs, high-speed imaging and laser diagnostics facilities, integrated with combustion test apparatus from static Diesel generators up to several megawatt industrial burners.

Centre for Integrated Renewable Energy Generation & Supply (CIREGS)

CIREGS is a multidisciplinary engineering group with international expertise in both the generation and transmission of energy. Of particular relevance to the automotive industry is the development of the necessary infrastructure for charging of electric vehicles. CIREGS is currently developing highly efficient, reliable and small-sized power electronics converters for Electric Vehicles through;

- using efficient wide-bandgap compound semiconductors, such as silicon carbide (SiC) power devices, to replace Si power devices to improve system efficiency and power density;
- advanced design of power topologies considering high frequency operation of SiC power devices;
- design of high-frequency inductors to reduce system size and weight;
- control system design to improve system dynamics.

Magnetics and Materials Group

The magnetics laboratories have a wide range of advanced facilities for the development, characterisation, imaging and modelling of soft magnetic materials subject to operational conditions of waveform, frequency, temperature and stress. The researchers have many years of experience working with several of the leading manufacturers of electrical steels and electromagnetic drives including the following automotive related projects:

- Optimisation of magnetic materials for high performance electric vehicle motors
- Modelling and characterisation of the influence of the manufacturing process on the magnetic performance of electrical steels
- Prediction of magnetic losses under high harmonic content magnetisation waveforms
- Influence of stress on magnetic properties of electrical steels

Applied and Computational Mechanics Group

The Group carries out internationally recognised research in the area of computational mechanics. Researchers develop and apply numerical and computational models to advanced materials, structures and processes to improve their efficiency, efficacy and economy.

Next Generation Technologies

Cardiff Catalysis Institute (CCI)

Catalysis can make a major contribution to the development of economic and environmentally sustainable manufacturing processes and the Cardiff Catalysis Institute (CCI) is recognised as a global leader. The centre has a successful track record working with a range of businesses, including leading automotive companies. The CCI's research includes;

Exhaust-gas reforming for waste heat recovery

As much as 70-75% of the energy in the fuel used by a car is turned into waste heat, with more than a third of this released through the exhaust pipe. In collaboration with combustion engineers at the University of Birmingham, the CCI has been developing a catalytic route for recovering exhaust heat.

By adding some of the fuel to a portion of the exhaust as it passes through a catalytic reactor fitted into an exhaust-gas recirculation loop, it is possible to produce a gas mixture with a higher heating value than the fuel itself.

Aftertreatment

The CCI is currently working on one of the outstanding challenges in environmental catalysis: to produce a four-way aftertreatment system for diesel and other lean-burn vehicles. A key stepping-stone is to combine NOx reduction with soot destruction, without either sacrificing fuel economy or increasing greenhouse gas emissions.

Institute of Compound Semiconductors

The Institute for Compound Semiconductors aims to position Cardiff as the European leader in compound semiconductors, providing cutting-edge facilities that help researchers and industry work together. The Institute for Compound Semiconductors will enable researchers and industry to collaborate to meet consumer demand by progressing academic research to a point where it can be introduced reliably and quickly into the production environment.

The Institute is also part of a broader vision to work with IQE and the Welsh Government to create the world's first compound semiconductor cluster in South Wales, under the brand CS Connected. This world leading initiative underpinned by £200m in investment will upscale the existing CS manufacturing infrastructure to provide a unique, large scale Pilot Line Foundry capability.

Data Managament

Cyber Security

The University hosts the Airbus Centre of Excellence in Cyber Security Analytics. The centre works across industry, academia and government to provide a focus for cyber security analytics in the UK. The centre is the first of its kind in Europe and aims to strategically position the UK as a leader in cyber security analytics.

The centre addresses emerging challenges to cyber security by combining:

- computational and mathematical methods, drawing on our technical expertise in machine learning, artificial intelligence and big data analytics
- criminological expertise in cyber crime
- international relations expertise in communication and governance

Data Analytics

Cardiff University is home to the Data Innovation Research Institute (DII)., which draws on expertise from staff from across the University. The DII has been set up to conduct fundamental research into the aspects of managing, storing, analysing and interpreting massive volumes of textual and numerical information.

Researchers are engaged in a wide range of projects with applications across many sectors, including automotive.

Psychology

School of Psychology

The School of Psychology has considerable experience in user behaviours and perceptions of conventional and electric vehicles. Since 2009 members of the School have been involved with research on conventional and electric vehicles through a number of research projects including:

- low carbon transport
- electric vehicles as part of smarter electric grids
- relevant customer behaviours such as behaviour change (adoption of eco-driving)
- adoption of electric vehicles fleets
- trust in autonomous vehicles.

Business Models

Centre for Automotive Industry Research (CAIR)

This centre studies the automotive industry from a business rather than technology perspective. Key areas for which CAIR has developed a reputation include the broad environmental impact of the sector and the reasons why it is dominated by mass production systems. A detailed historical analysis of the latter has led to both a questioning of the sustainability of mass production and the reasons why low volume specialist car production systems continue to be viable. In this context, CAIR has considered both the economics of the use of alternative materials for vehicle structures as well as alternative, more sustainable, business models that involve low volume production and greater product durability.

Electric Vehicle Centre of Excellence (EVCE)

Combining expertise from the School of Engineering, the Business School's Centre for Automotive Industry Research (CAIR) and the School of Psychology, the EVCE has a successful track record in various aspects of the Electric Vehicle (EV) value chain, including areas such as ;

- smart grids
- energy demand scenarios for EVs
- regulatory options
- consumer barriers and incentives

The aim of the EVCE is to investigate and help address the remaining barriers to the widespread introduction of electric vehicles.

Applying Research

We are practiced at working with organisations to develop unique initiatives to address industrial needs. Formula student and the National Software Academy are just two examples of how we can collaborate with industrial partners.

Formula Student

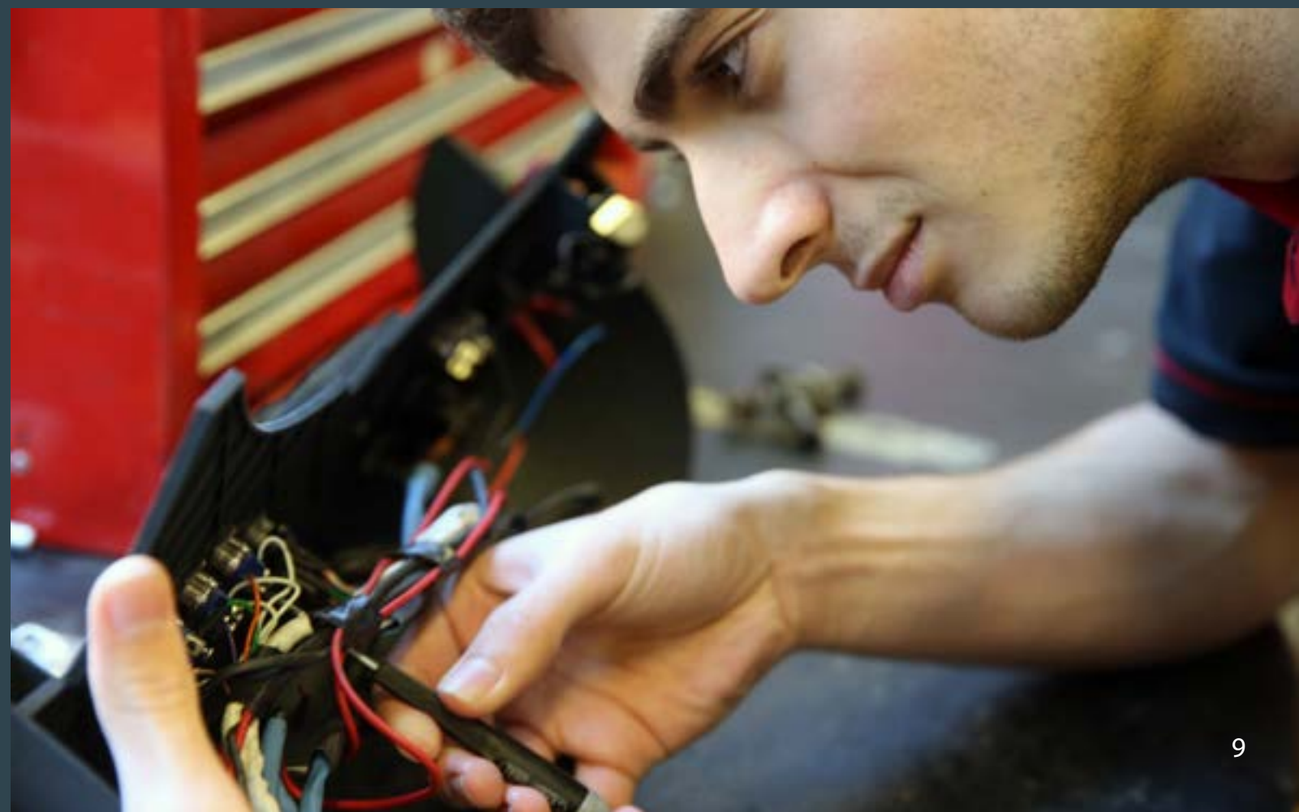
Cardiff Racing is a Formula Student team made up of students from a range of engineering disciplines and academic years and provides an opportunity to apply the theory learnt in lectures to a real life environment. The team is highly successful and consistently ranked in the top five teams across the UK. They have also competed internationally through the University's participation in the Global Engineering Education Exchange program and were ranked 9th out of 120 teams from across the world in 2014.

The team works closely with a number of sponsors that provide access to cutting-edge facilities as well as financial support. In addition to racing, there is also a strong emphasis on promoting careers in science and engineering and the team has a very active schedule of school visits.

National Software Academy

The National Software Academy (NSA) is a centre of excellence for software engineering which produces work-ready graduates with industrial experience. Working in partnership with Welsh Government and industry leaders, the Academy is an innovative Cardiff University initiative to tackle a national shortage of skilled programming and software engineering graduates.

Based in Newport, the Academy delivers a degree focused on the knowledge and hands-on experience needed to work as a commercial software engineer. It developed its three-year BSc Applied Software Engineering course in collaboration with industry. Taught by academics and industrial practitioners, students deliver real software projects, teaming with other students and lecturers in a vibrant start-up atmosphere. The programme applies cloud, mobile and web technologies to real projects.



Working with us

We work with businesses and organisations, of all sizes and sectors, and provide a range of mechanisms to enable partners to access to our knowledge, expertise and facilities.

Student Placements and Projects

As a Russell Group University, we attract top students from around the globe. Recruiting our students and graduates will supply your workforce with talented, enthusiastic and highly capable individuals, with a zest for learning and application. We offer a range of options for engaging with our students, from sponsored PhD studentships, to year in Industry and more short term opportunities.

Knowledge Exchange

Our key enabler for knowledge exchange is the Government-sponsored Knowledge Transfer Partnership (KTP) scheme. Via a KTP, you can access our academic expertise and employ graduates to work on projects of strategic need to your company, with the aim to improve competitiveness, productivity and performance. Cardiff has an excellent track record of applying, securing and managing KTP projects, with a greater than 90% success rate, delivering over 250 projects to date.

Research and Development Partnerships

Cardiff University prides itself on conducting curiosity-driven research with impact and applications in real scenarios and businesses. Researchers are engaged in a diverse range of research collaborations with other research institutions and businesses, both in the UK and internationally, attracting significant funding.

Networking and events

The Cardiff University Innovation Network has been established for over 20 years. Through a series of free events throughout the year, covering topics on innovation, enterprise and entrepreneurship, the network aims to encourage innovation and collaboration between academia, business and government. Organisations can utilise the platform to engage the business community by attending and participating in events.

GW4 Alliance

Cardiff University is part of the GW4 Alliance which brings together four of the most research-intensive and ambitious universities in the UK; the universities of Bath, Bristol, Cardiff and Exeter. The universities anchor the regional economy through income, employment, knowledge exchange and collaborations with business.

Through the GW4 Alliance, organisations can access the combined expertise of all four universities in areas such as advanced engineering and digital innovation and forge collaborations at a globally competitive scale.

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