Department of Mechanical Engineering

We are one of the UK’s leading Mechanical Engineering departments, ranked 3rd by the Guardian University Guide 2014, with a reputation for outstanding teaching, innovative research and strong links with industry. The 2008 Research Assessment Exercise rated the majority of our research as world-leading or internationally excellent.

Our academic staff, research fellows, post-doctoral researchers and PhD students carry out acclaimed work and publish in international journals. We also have several prestigious research centres including the Centre for Powertrain and Vehicle Research, which is one of the leading UK university groups in the field.

Automotive Research at Bath

The Powertrain and Vehicle Research Centre works in partnership with industry to deliver sustainable powertrain technology. We specialise in integrated systems analysis and control, experimental evaluation, modelling and simulation. We aim to meet the requirements of industry to access high-quality research in an academic environment employing state-of-the-art analytical and experimental tools.

We offer analytical expertise, informed by extensive experimental validation, where engines and complete powertrain systems can be studied in controlled environments that closely replicate on-road conditions.

We work closely with industry and value the access to challenging engineering problems that this approach gives us. We adopt industry standard tools, but also investigate the fundamental science underpinning the work, in order to improve the understanding of the system and to enhance the development methods used within our partners’ businesses.

Our work is directly supported by our industrial partners, the Research Councils and the Technology Strategy Board (TSB).
**Our People**

**Professor Gary Hawley**  
**Medlock Chair of Engineering**  
Professor Hawley is the Dean of the Faculty of Engineering and Design and director of the Powertrain and Vehicle Research Centre. His expertise spans a broad range of diesel engineering, including fuel efficient vehicles, precision measurement of CO₂ emissions and the impact of biofuels on engine and after-treatment performance. His research has strong applications in industry and most notably the 1.0L Ford Ecoboost engine that received international Engine of the year 2012.

**Dr Chris Brace**  
**Reader in Automotive Engineering**  
Dr Brace leads a wide portfolio of powertrain-based research projects with a common theme around the intensive measurement, analysis and control of multi-cylinder engine systems running under dynamic operating conditions. Dr Brace is also interested in human behaviour when driving and the impact this can have on fuel economy. Dr Brace is chair of the Automobile division of the Institution of Mechanical Engineers (IMechE, 2012-14).

**Dr Sam Akehurst**  
**Lecturer in Automotive Engineering**  
Dr Akehurst’s research focuses on the performance of future powertrain systems with respect to CO₂ reduction. His expertise spans internal combustion engines, turbocharging and Continuously Variable Transmissions (CVTs). He combines simulation and experimental methods, having developed bespoke equipment for replicating the air supply capabilities of turbomachinery. He has used this facility for the development of Ultraboost, a 60% downsized engine, in collaboration with Jaguar LandRover.

**Dr Chris Bannister**  
**Lecturer in Mechanical Engineering**  
Dr Bannister leads research into alternative fuels within the department of Mechanical Engineering. He works in collaboration with the departments of Biology, Chemistry and Chemical Engineering, evaluating the impacts of alternative fuels on powertrain systems. Working closely with BP and Ford, his research has investigated engine performance and the behaviour of after-treatment and lubrication systems when using novel fuels. Chris’s other research areas include improving the accuracy and repeatability of vehicle emissions measurements and the development of exhaust after-treatment systems.

**Dr Colin Copeland**  
**Lecturer in Mechanical Engineering**  
Dr Copeland has a specialist background in turbocharging and boosting for downsized engines. His research focuses on improving the understanding of the interaction between turbochargers and the internal combustion engine; notably, he seeks to measure and model effects of pulsating flow and heat transfer. Colin is also interested in heat recovery through new technologies, such as turbocompounding and Rankine cycles.

**Dr Jos Darling**  
**Senior Lecturer in Mechanical Engineering**  
Dr Darling’s expertise is in the area of Vehicle Dynamics, specialising in active suspensions, towed vehicles and tilting three-wheeled vehicles. His research includes the control of the tilting CLEVER car to replicate motorcycle handling and improving the stability of caravan towing with a local manufacturer Bailey Caravans. Dr Darling also has an interest in engineering education and game-based learning and has won several international prizes for learning and teaching.

**Dr Kevin Robinson**  
**Senior Lecturer in Mechanical Engineering**  
Dr Robinson’s research focuses on all aspects of fundamental heat transfer in internal combustion engines both experimentally and in simulation. He has studied a broad range of topics, including the engine internal cooling passages, vehicle braking systems and exhaust catalysts. Kevin also undertakes a key role in the organisation and supervision of the formula student activity, which has been very successful over recent years.

**Dr Richard Burke**  
**Research Fellow in Automotive Powertrain Systems**  
Dr Burke’s research focuses on the transient operation of future powertrains. Using dynamic design of experiments methodologies, he aims to replicate realistic driving scenarios in the laboratory and to develop new mathematical models capable of predicting this behaviour. His work will allow the next generation of hybrid and electric vehicles to be optimised for real-world conditions. Richard has many international links in Germany, France and Spain and supervises joint projects with universities in these countries.

**Dr Chris Chuck**  
**Whorrod Research Fellow in Sustainable Chemical Technologies**  
Dr Chuck works in the Department of Chemical Engineering on the production of alternative fuels; he aims to develop a sustainable biorefinery where fuels, chemicals and animal feed can be produced economically without impacting heavily on food and fresh water resources. His research is leading to the application of alternative chemical methods to fuel synthesis, to address both the sustainability of biofuels and also the poor performance and compatibility with powertrain systems.
Taught Programmes

At the University of Bath we offer a four-year MEng and one-year full-time MSc in Automotive Engineering. Our programmes will equip you with the skills and knowledge you need to build a successful career in engineering.

Nationally, we are ranked 1st in the UK for student satisfaction (National Student Survey 2013) and 3rd in the UK for Mechanical Engineering (Guardian University Guide 2014). We were also ranked 1st for employability (career after 6 months) in the Guardian University Guide 2014.

MSc Projects

Our postgraduate taught programmes will sharpen your technical skills and teach you about engineering in a business context. They include subject-specific units and business and group orientated work as well as detailed technical projects that are carried out under individual supervision.

Students work on industry-backed research throughout their time at Bath. MSc students get involved with ongoing research as part of their individual research projects, which is an excellent opportunity to interact closely with other researchers and industrial partners. During this period, many MSc students make the decision to continue with automotive research, with some staying on to study for a PhD with the automotive group at the University. Past projects have included:

- Two stage turbocharging of diesel engines
- Variable geometry turbochargers for gasoline engines
- Particulate size distributions for highly boosted gasoline engine
- Investigating the impact of twin skin exhaust systems on exhaust gas temperatures
- Dynamic design of experiments and modelling of diesel engine emissions for system calibration
- Simulating the impact of look-ahead strategies on hybrid vehicle control
- Heat transfer characteristics of a novel disc brake
- Predicting the impact of vehicle calibration on catalyst light-off
- Composite energy absorption structures for automotive use
- Formula student race car development
- Cryogenic machining of carbon fibre for light-weight racing parts
- Vehicle mechatronic energy recovery systems
- CFD simulation of automotive compressor inlet geometries for improved performance
- Flywheel kinetic energy recovery system for passenger vehicles
- Driver behaviour and real-world effects on optimisation of hybrid vehicles
- Energy and exergy analysis of an internal combustion engine system
- Assessing powertrain performance over current and future legislated drive cycles
- Noise and vibration in passenger vehicles
- Driver information systems for reduced fuel consumption and CO₂ emissions
- Life Cycle Assessment (LCA) of hybrid vehicle powertrains.

Admissions criteria for MSc Automotive Engineering

A first or upper second class UK honours degree or internationally recognised equivalent in Mechanical Engineering.

IELTS 6.5 (with not less than 6.0 in each of the four components) or equivalent may also be required. Equivalents include 92 or equivalent may also be required. Equivalents include 92 in TOEFL internet-based test, with not less than 21 in writing, 22 in speaking, 22 in reading; or a minimum of 62 in PTE Academic, with no less than 50 in each component.

Research Degrees

PhD research at the University of Bath is linked closely with industrial collaborations. A PhD student can expect to have responsibility for focused and complex aspects of a larger study. This provides the opportunity to concentrate on a challenging area, spending the time to investigate in more detail an area beyond that of the initial industry-funded project to improve knowledge and understanding.

Students are encouraged to lead their own research, with the support of an academic supervisor, directing it towards their area of interest and changing direction as new gaps in understanding arise.

Current and recently completed PhD Projects

- Vehicle and engine biodiesel investigations
- Modelling and simulation of an aftermarket hybrid electric vehicle
- Renewable liquid fuels from microbes for aviation and road transport use
- Variable geometry turbochargers for gasoline engines
- Advanced turbocharger systems for diesel engines
- Understanding combustion in highly downsized engines
- Improving the efficiency of electric machines for hybrid vehicles
- Characterising and predicting damper behaviour in automatic transmissions
- Improved driver models for traffic simulation
- Advanced supervisory control strategies for hybrid vehicles
- Driver assistance systems to improve fuel economy
- Improved measurement and prediction of heat transfer in diesel engines
- Real-time heat release modelling of an HSDI diesel engine
- Investigation into the interactions between thermal management, lubrication and control systems of a diesel engine
- An investigation into novel hybrid vehicle powertrain configurations with the application of the Milner continuously variable transmission
- Engine optimisation for downsizing by experiment and by simulation
- The dynamics and control of a three-wheeled tilting vehicle
- Simulation of cyclic variability in gasoline engine under cold start conditions
- Oxidation catalyst studies on a diesel engine
- Air charge system emulation for diesel engine
- Vehicle emissions measurement techniques
- Engine thermal management in light duty diesel engine
- The application of multivariate correlation techniques to vehicle driveability analysis
- Causal tracking control of a non-minimum phase HIL transmission test system.

Research areas for future PhD projects

These are the areas of research we expect a majority of upcoming PhD projects will cover. If you would like to discuss an area in more detail, or enquire about other areas of research, please get in contact with Dr Chris Brace.

- The impact of real-world driving conditions on vehicle emissions
- Novel turbocharging and supercharging studies
- Engine downsizing
- Vehicle emissions measurement techniques for improved accuracy
- Optimising engine performance for alternative fuels
- Replicating driver behaviour and real-world conditions on a rolling road
- Development of novel hybrid vehicle powertrains
- Vehicle after-treatment studies
- Vehicle emissions measurement techniques
- Engine thermal management in light duty diesel engine
- The application of multivariate correlation techniques to vehicle driveability analysis
- Causal tracking control of a non-minimum phase HIL transmission test system.
Scholarships, Funding & Fees

The University of Bath offers a range of scholarships for home, EU and international students undertaking postgraduate study within the Faculty of Engineering & Design.

To apply for an MSc Scholarship you need to firmly accept a conditional or unconditional offer of a place on your taught master’s programme.

There are a range of funded PhD opportunities, scholarships and studentships for prospective PhD students. University of Bath MSc students can get a University of Bath PhD scholarship.

“I made a wise choice to study at the University of Bath. I was awarded the Elite Master Scholarship and Frank Wallace Scholarship to undertake my MSc in Automotive Engineering. The quality of education I received, through fast-paced lectures and research projects, convinced me to stay at Bath as a PhD student within the Powertrain and Vehicle Research Centre. The combination of PhD discount for Bath MSc students and receipt of the Medlock Scholarship has covered my expenses so I can devote most of my time to research.

The state-of-the-art facilities and close ties with industry allowed me to take part in the development of technologies that will shape the future. The time in Bath has been so much more than education; it was here that I truly found my passion and my confidence.”

Qingning Zhang

Further Information

To find out more visit our web pages for the latest information on scholarships and funding:

www.bath.ac.uk/engineering/graduate-school/funding

For up-to-date information on the current fees for postgraduate taught and research degrees visit:

www.bath.ac.uk/study/pg/fees

Employment in Automotive Engineering in the UK

Engineering now accounts for almost a quarter of the turnover of all enterprises in the UK, and almost 20% of the working population work in engineering enterprises. Engineering and technology graduates have the second highest mean average starting salary in the UK, which is a fifth more than the mean for all graduates.

The UK employment market has seen increasing demand for candidates in the engineering and manufacturing market, especially in automotive. Every 20 seconds, a car, van, bus or truck rolls off a UK production line. Automotive is one of the UK’s leading export sectors by value, with over 80% of these vehicles exported to more than 100 countries.

University of Bath graduate employability

University of Bath engineering graduates have excellent employment prospects with 92% in employment or further study after 6 months. The success of our graduates is due to strong collaborative links with industry, and our excellent reputation for producing high quality graduates.

Many MSc and PhD students move directly into employment with the organisations that supported their research due to the close interaction with those companies during their projects. Others choose to look elsewhere, but the experience gained during their studies and research at the University of Bath provides excellent industrially-related experience which holds them in good stead during interviews and their future careers.

The Intersyn advanced transmission research facility - A flexible transmission test facility built to match customer requirements

The chassis dynamometer and robot driver
Projects with Industry

The University of Bath has an excellent reputation for working with industry and transferring our research knowledge into businesses and other organisations. The Powertrain and Vehicle Research Centre is at the forefront of collaborative research enabled by long-term partnerships with companies such as Ford and Jaguar LandRover.

Our expertise is available for consultancy and project work, ranging from short test campaigns to custom-designed research programmes lasting months or years. The experimental facilities have been designed with flexibility in mind and are suitable primarily for passenger car and light commercial powertrains, although products from other sectors can also be studied.

Transferring high precision evaluation to Ford Motor Company

The Powertrain and Vehicle Research Centre has particular expertise in providing accurate and reliable measurements to the automotive industry, with much of this testing involving computer-controlled simulations that emulate standardised urban or extra-urban driving conditions. They helped Ford achieve improvement in various ways, ranging from greater precision in measuring exhaust gas emissions and fuel consumption with the aim of reducing them, to rigorous and repeatable drive cycle procedures.

“As consumption and emissions fall, any benefits become increasingly difficult to measure, which is why this project has been so useful. By making our test procedures more discriminating, it allows our development engineers to make best use of our facilities. Some of these improvements have been carried over to other [Ford] labs, particularly in Germany and the United States”.

Dr Phil Price, Technical Specialist, Vehicle Evaluation & Verification Europe, Ford Motor Company Ltd.

Air charge management - Turbo Centre
Collaboration with Ford Motor Co. Ltd, Jaguar LandRover Ltd, Cummins Turbo Technologies Ltd

The research team at Bath worked closely with its industrial partners - Ford, Jaguar LandRover and Cummins Turbo Technologies – to refine the systems that had been developed and to embed into industry a set of tools designed to accelerate and improve the process of designing turbocharged engine systems.

The introduction of turbocharged engine systems results in vehicles that use less fuel without losing power. This allows the automotive industry to reduce carbon dioxide emissions and the running costs of a vehicle for the consumer. Research and development of this nature also gives the companies involved in the project a competitive edge in the sector, potentially allowing business growth. The KTA project has further developed the existing relationship between Bath and its industry collaborators.

Developing a second generation hybrid system with Ashwoods Automotive Ltd

The University team developed the next generation of a hybrid system, designed for retrofitting to small commercial vehicles. They optimised and recalibrated the control system leading to improved fuel savings.

By taking the expertise in powertrain systems and carbon dioxide reduction already developed at Bath and combining it with Ashwood’s hybrid product and design expertise, they created a unique system that offers a very good cost/benefit ratio. In addition, they were involved in a commercial driver monitoring and training tool that is being used by a number of large companies to ensure their drivers are not wasting fuel and are driving efficiently.

Thanks to our industrial collaborators & funding bodies, which include:

- Ford Motor Company
- Jaguar Land Rover
- EPSRC
- Technology Strategy Board
- Bailey Caravans
- Ricardo Consulting Engineers
- Cummins Turbo Technologies
- Intersyn Technologies
- IAV
- Cummins Power Generation
- Ashwoods Automotive
- Castrol
- Mahle Powertrain
- CP Engineering
- CD Adapco
- GE Precision
- Lotus Engineering
- Shell
- First Bus
- Orbital Traction

Dynamic engine test cell
Expertise

**Diesel engine combustion research** is a major focus of our research. Understanding the complex interactions between the many mechanisms responsible for modern diesel engine performance is vital in achieving a capable product. Our work contributes to that understanding through a full range of activities, from the fundamental modelling of combustion through to the design of multi-variable experimental programmes.

**Turbocharging and air charge management** has been a key topic in diesel engines for many years; now it is an important enabling technology in highly downsized spark ignition engines. Our work has focused on dynamic modelling and evaluation of turbocharger systems and their interactions with the combustion and emissions control aspects of engine performance. Our unique boosting system emulator allows the effect of novel boosting technologies on engine performance to be examined long before any prototype hardware becomes available.

**Ultraboost programme**

The Ultraboost engine running at high load in dynamic cell

**Alternative fuels and emissions after-treatment** activity within the PVRC focuses on a detailed understanding of the effect of alternative fuel composition on combustion in the engine and on the after-treatment devices. This work is in collaboration with biologists and chemists at the University, resulting in a total life cycle approach to alternative fuels, as well as developing novel, non-food sources of liquid fuels. After-treatment development research has included fundamental transport delay investigations for improved catalyst conversion efficiency calculations, diesel oxidation catalyst passive NOx conversion investigations, and low-temperature performance of state-of-the-art emissions control technologies.

**Integrated powertrain control and advanced transmission systems** have been recurrent themes within the group for over at least three decades. Subsequent work has involved a variety of CVT and discreet ratio transmissions coupled to gasoline and diesel engines. Increasingly demanding emissions and fuel consumption requirements have promoted a renewed emphasis on coordinating the control of the engine and transmission together with measures to monitor and influence driver behaviour.

**Innovative engine and powertrain thermal management**, particularly on IC engines. The aim is to offer a cost-effective route to improving emissions and fuel consumption. Coolant side engine heat transfer studies are specifically focused towards the development of precision cooling strategies. The work includes characterising the nature of heat transfer in simulated engine cooling galleries, in parallel with the development of accurate predictive tools to enhance the engine design. This work has demonstrated significant opportunities for reduced warm-up times and CO2 emissions.

Modelling and optimisation for the analytical engine and powertrain is a topic that intersects with all of our activities. Key achievements to date include:

- Real-time engine and turbomachinery simulations development for use in advanced software and hardware in the loop experimental work
- Use of dynamic design of experiments and Bayesian approaches (the use of prior knowledge to accelerate model development) to develop high-fidelity system models in a timely manner
- Advanced design experiment procedures use such models in expert knowledge-led procedures for the Multi-variable optimisation of engine calibrations by the use of advanced design experiment procedures
- Driveability assessments focusing on the impact of dynamic powertrain control techniques on longitudinal acceleration behaviour. The objective assessment of subjective driveability on test rig allows the optimisation procedures to take account of driver acceptance criteria as part of an integrated approach to rig-based calibration. The work has its roots in vehicle-based studies but the knowledge gained can be transferred to the rig environment to accelerate development programmes.

**Hybrid and electric powertrains** are an increasing aspect of our research via a number of collaboratively-funded activities. The emphasis is on solving real-world problems around the modelling, control and optimisation of the devices within an integrated system. Cost-effective integration of electrical devices within a vehicle powertrain is a significant challenge and requires detailed understanding of the entire system.

Cell 2 has a dual dynamometer arrangement capable of absorbing 500kW.
Our Facilities

The Powertrain and Vehicle Research Centre (PVRC) specialises in powertrain systems analysis, evaluation and control. We aim to deliver exceptional quality research in an academic environment, employing state-of-the-art analytical and experimental tools.

As part of the Department of Mechanical Engineering at the University of Bath, we are one of the leading UK university groups in the field; we work closely with industry and value the access to challenging engineering problems that this approach gives us. We investigate the fundamental science in order to improve the understanding of a variety of powertrain systems, including petrol and diesel engines, turbocharging and supercharging, electric motors and hybrid-electric systems. Highly-capable experimental and modelling facilities have been developed to support this research; some of these include:

**Dynamic engine test cells:**
Three state-of-the-art engine research platforms deliver fully transient analysis of engine performance, emissions and fuel economy. A centralised emission measurement facility houses cutting edge emissions analysers, allowing the measurement of pre- and post-catalyst exhaust gas emissions concentrations under a variety of engine operating conditions. A unique turbocharger emulation system allows the study of boosted intake air pressures for high-performance engines.

**Turbocharger hot gas stand:**
A new, high-temperature gas supply facility is used to study turbocharger performance in a controlled research environment. Research associated with turbomachinery aerodynamic performance, heat transfer and unsteady gas dynamics are all a focus of study in this facility. Other novel uses of this capability are research into high-temperature heat exchangers and micro gas turbines.

**Chassis dynamometer:**
A flexible and capable vehicle test facility allowing the evaluation of whole-vehicle performance. A temperature controlled environment allows climatic vehicle testing from -10 to +50°C. The facility is the only one of its kind in the UK capable of accommodating 4WD conventional and hybrid vehicles with unparalleled emissions detection functionality. A suite of emissions analysers are able to assess standard emissions species such as carbon dioxide and hydrocarbons, as well as particulate sizes and nitrogen-based compounds relevant for NOx after-treatment development research.

**Advanced transmission research facility:**
A flexible test facility has been built to study a range of transmission solutions for the modern vehicle powertrain. Two ABB motor/dynamometer drives are arranged back-to-back to allow detailed testing of multiple speed gear-boxes, continuously variable transmission and hybrid drives.

**Hybrid and electric powertrain facilities:**
Electric and hybrid-electric vehicles are an increasingly important aspect of our research focus; this is reflected in new dedicated facilities to test electric motors and range extender powerplants for hybrid vehicles. Effective integration of electrical devices within a powertrain is a significant challenge and requires detailed understanding of the entire system.

**Modelling and optimisation:**
Use of advanced modelling tools to analyse the engine and powertrain interactions intersects with all of our activities. Key aspects of simulation include real-time engine and turbomachinery simulations, Computational Fluid Dynamics (CFD), advanced design of experiment (DoE) procedures and development of state-of-the-art control algorithms. The group makes use of the University’s High Performance Computing (HPC) system or a dedicated 16-core PVRC workstation for intensive simulations where it is needed.

**Key contacts**

**PhD Enquiries**
For more information on how to apply for research degree at the University of Bath please visit [www.bath.ac.uk/engineering/graduate-school/pg-research/how-to-apply](http://www.bath.ac.uk/engineering/graduate-school/pg-research/how-to-apply) or contact:

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**MSc in Automotive Engineering Enquiries**
For more information on how to apply to the MSc Automotive Engineering programme, please visit [www.bath.ac.uk/engineering/graduate-school/pg-taught/automotive](http://www.bath.ac.uk/engineering/graduate-school/pg-taught/automotive) or contact:

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