Design, Innovation and Competition - Establishing the Balance

given by

George W. Buckley
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1971
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1972
Some Thoughts on Design-and Designers
Dr T Emerson
GKN Ltd

1973
The Design Council and Engineering
G E P Constable
Head of Engineering Design, Design Council

1974
Design as a Team Game
E McEwen Vice-Chairman
Engineering Joseph Lucas Ltd

1975
The Ralph Shire Memorial Lecture:
Some Details Design Problems in Aircraft Gas Turbines
L Haworth FRS
Director, Rolls-Royce (1971) Ltd

1976
Innovation in Engineering Design
Dr A Moulton CBE
Director Molton Developments Ltd

1977
Ship Design
R J Daniels OBE
Director General of Ships & Head of Royal Corps. of Naval Constructors

1978
The Design’s Craft
Dr G B R Feilden CBE
Director General British Standards Institution

1979
Design for Maintenance in British Rail
K Taylor
Chief Mechanical & Electrical Engineer British Railways Board

1980
Effective Industrial Innovation and its Contribution to Britain’s Economic Recovery
V J Osola
Chief Executive Redman Heenan International

1981
Investment in New Product Development
Viscount Caldecote DSC FEng
Chairman Delta Group plc

1982
The Context of Design
Sir Kenneth Corfield
Chairman & Chief Executive Standard Telephones & Cables Ltd

1983
Higher Innovation - The Management of Creative Disorder
Sir Basil Blackwell FEng
Vice-Chairman & Chief Executive Westland plc

1984
Designing for Dependability in Advanced Power Plant & Associated Systems
Dr W Rizk CBE FEng FI MechE
Chairman GEC Diesels Ltd and GEC-Ruston Gas Turbines Ltd

1985
Better Design for British Industry
Sir William Barlow FEng
Chairman & Chief Executive of BICC, Chairman of the Design Council

1986
The Car of the Year 2000
A.C. Rudd BSc (Eng) FSAE
Managing Director Lotus Engineering Ltd

1987
Design for Living
Sir Montague Finniston FEng FRS

1988
Design: The Common Goal
John Butcher M.P.
Parliamentary Under Secretary of State Department of Trade & Industry

1989
Industry: Design & Young People
Ivor Owen
Director - The Design Council

1990
Effective Management of Design
Peter Hills
SERC Engineering Design Co-ordinator The Design Council

1991
Competing with Better Products in Less Time
Keith Nichols
UK Marketing Manager (CIM) Digital Equipment Ltd

1992
Concorde and its Successor
Sidney Swadling
Director of Engineering British Aerospace Airbus Ltd

1993
Metrology in the field of Engineering
David McMurdy
Chairman & Chief Executive Renishaw plc

1994
Tribology in Machine Design
Professor Duncan Dowson CBE, FRS, FEng
The University of Leeds

1995
Design To Thrive
Prof. Ivan Yates CBE FEng
Royal Academy of Engineering Visiting Professor, Eng Dept. University of Cambridge
Council Member, The design Council
Welcome to the 2009 Design and Project Exhibition and the Joseph Black Lecture given by George Buckley of the 3M Corporation, a byword for innovation.

This booklet contains details of the 13 Group Design and Business projects, including 5 Aerospace projects undertaken by 3rd year students and the 161 engineering projects taken by 4th students. Details of all projects are included on the Departments website at http://www.bath.ac.uk/mech-eng/design-exhibition. For the first time we are executing some mixed teams of Electrical and Mechanical Engineers, which reflects the importance of this integrated view of modern engineering.

The Department is also illustrating its research activity, with posters illustrating work from its main research centres and units, see http://www.bath.ac.uk/mech-eng/research/. We are very happy to discuss any of this work with our industrial visitors as it will be seen that a considerable amount of the activity has good industrial synergy. Contact names are included on the posters and on the website.

On a sad note I have to report the passing of one of the founding fathers of the both the University and the Department, Professor Frank Wallace, who died earlier in the year, a summary of Frank's life and career is included. I can do no better than to repeat the words of the Dean, Professor Gary Hawley, who worked closely with Frank for many years “Small in stature but colossal in presence”. Still working in the Department until just before his death, he will be missed.

Innovation is one of those topics that currently in the ether, the Government has its 'innovation agenda' promoted by the Technology Strategy Board (TSB) See http://www.innovateuk.org/deliveringinnovation.ashx. The Royal Academy of Engineering(RAEng) is sponsoring a number of visiting professors in Innovation, of which one has been appointed at Bath. Gareth Jones, former Chief Designer at Dyson Appliances. The remit is to explore ways in which the innovation agenda can be developed and incorporated within an undergraduate and research agenda.

One of the organisations in the world that knows how to innovate is the 3M Corporation, which has been in business since 1902 and has a continual stream of innovative, useful and profitable products to its name. This has included the Scotch tapes range and brand(1925) and the ubiquitous Post-It note(1980). Thus it is thus particularly appropriate that we have Dr. G.W.Buckley, Chairman, President and CEO of the 3M Corporation, her to tell us how it is done and to deliver the 2009 Joseph Black lecture:

“Design, innovation and competition-establishing the balance”.

Professor Steve.Culley
On behalf of the design team.
Emeritus Professor Frank J, Wallace FREng
27th May 1924 - 22nd January 2009.

In 1965 Frank Wallace was appointed to a Professorship at what was then the Bristol College of Science and Technology which a year later became the University of Bath. A new campus was established at Claverton Down. Frank Wallace was a founding father of the new university. In addition to pursuing his research activities he established a successful post graduate course in Internal Combustion Engineering and he also was instrumental in introducing undergraduate courses in French and German. He was also active in promoting collaborative research with industry and other Universities and was chairman of the Institution of Mechanical Engineers' Combustion Engine Group.

Frank Wallace was 15 years old when he left Nazi Germany to seek asylum in Britain in 1939. He was fortunate in having friends to assist him and after attending Monkton Combe School in Bath, in 1942 he was awarded a Scholarship to read Mechanical Engineering at the University of Birmingham. It was clearly a worrying time for a young man who had left his family in Germany, but he graduated with a 1st Class degree in January 1944. The head of Department in Birmingham invited Frank Wallace to join his small research team. At that time, there were no computers available and electronic Instrumentation was in its infancy. Research students had to design and construct their own research equipment using any material that happened to be available.

Following his work for a master's degree, Frank spent two years as a graduate apprentice at GEC in Birmingham before returning to the University as a Lecturer. He was a natural researcher and the Internal Combustion Engineering became his main research interest. In 1959 he moved to the Queen's University, Belfast as a Senior Lecturer and in 1964 was promoted to a Chair of Mechanical Engineering at that institution.

He was one of an elite group of early pioneering researchers who were instrumental in opening up the USA to British engineers. Throughout a lifetime of intellectual endeavours focusing on diesel engine research Frank received substantial recognition through his Fellowships of the Royal Academy of Engineering and the Society of Automotive Engineers. In his specialist research area of turbocharging the internal combustion engine, he had no equal. Frank was a true gentleman and a scholar with a genuine interest and warmth for his subject and especially his students. Up until a few months ago at the age of 84 he was actively supervising research students and writing technical papers.
2009 Joseph Black Lecture

Design, innovation and competition
- establishing the balance

George W. Buckley

3M
Chairman, President and Chief Executive Officer
3M Corporate Headquarters
3M Centre
St. Paul, MN 55144-1000
George Buckley, Chairman and Chief Executive Officer of the 3M Corporation

3M is the 25th largest corporation in America (by market Capitalization). 3M is well known as a legendary innovation "machine". The critical aspect of growing businesses is the issue of value creation in corporations and it is here that innovation is a principal driver.

The principal factors in developing an innovation culture are critical and these will be developed in more detail in the presentation, as will how companies can use this in challenging economies to win the competitive game.

3M's vision is to be the most innovative enterprise and our customers' preferred supplier. Innovation applies not just to our products but also to our whole business approach, encompassing social and environmental issues. Everything we do is underpinned by our Corporate Values and our day-to-day actions are guided by an overarching Business Conduct Manual. Part of this is to act with uncompromising honesty and integrity in all activities, satisfy customers with innovative technology and superior quality, value and service and value and develop our employees' diverse talents, initiative and leadership. This in turn will earn the admiration of all those associated with 3M worldwide.
The underlying technologies that 3M employs are many and varied and it is this that supplies the platform for development and growth.

- Abrasives
- Acoustic Control
- Adhesives
- Advanced Materials
- Analytical Science and Technology
- Application Software
- Biotechnology
- Ceramics
- Drug Delivery
- Display
- Dental and Orthodontic materials
- Energy Components
- Electronic Materials
- Flexible Converting and Packaging
- Flexible Electronics
- Films
- Fluorinated Materials
- Filtration, Purification and Separation
- Imaging
- Inspection and Measurement
- Integrated System Design
- Light
- Medical data Management
- Metal matrix Composites
- Molding
- Micro replication
- Nanotechnology
- Non wovens
- Optical communications
- Particle and Dispersion processing
- Polymer Melt Processing
- Porous materials and membranes
- RFID
- Radiation Processing
- Sensors
- Speciality Materials
- Surface Modification
- Vapour Processing
- Accelerated Weathering
- Wound Management

Some extended examples are included below

**Integrated System Design**

Complex systems require comprehensive engineering; by integrating software, electronic and mechanical expertise, 3M creates systems that complement each other and enable exceptional performance. These disciplines are further enhanced by predictive modelling, human factors engineering and industrial design. The result is a blend of functionality and elegance, in products as simple as a tape dispenser or a sanding tool and as complex as 3M's multi-dimensional circulation and security systems for libraries.
Adhesives
So strong, they can hold a structural panel for the life of a building... so gentle they yield to a child. Because 3M adhesives have been engineered to fit our customers' needs, they are used in such diverse products as aeroplanes, mobile phones, automobiles and medical dressings. We excel in curable adhesives and epoxies. Also, of course, pressure-sensitive tapes, which 3M invented more than 80 years ago.

Advanced materials
When 3M scientists begin work on a customer's problem, they draw on a remarkable array of advanced and specialty materials: polymers, composites, ceramics, fluoromaterials, nanomaterials and more. Our laboratories constantly add to this palette with new formulations and breakthrough modifications of existing materials. 3M is unmatched in the application of these novel materials to the demands of real-world manufacturing.

Analytical Science and Technology
New-to-the-world technologies generate both solutions for our customers and a host of questions for our scientists. What is this? How does it work? Can we make it better? To answer those questions, 3M has developed an unrivalled capability for measuring, characterizing, and understanding materials and processes. With resources located around the world, 3M scientists can draw on our analytical strengths during all phases of product development, from conception through manufacturing to commercialisation.

Thus the issue of the balancing design, the use of technologies, innovation and competition to establish value creation for the business and all the stakeholders in the business is one that is at the forefront of all 3M planning and development.
MEng Group Business and Design Projects
**Design Brief**

An existing three-axis parallel kinematic manufacturing platform is to be developed into a desktop sized machining workstation, suitable for general machining of aluminium and also the manufacture of orthotic insoles from polypropylene (PP) and ethylene-vinyl-acetate (EVA).

**Specification/Key Issues**

The design brief was developed to highlight five key areas of design for the machining workstation. These are:
- Machining Spindle & Tool Management,
- Waste Management,
- Cooling System,
- Material Handling, and
- Extra Degrees of Freedom

The individual designs are to be additions to the existing platform to enable it to compete as a marketable product in both the general machining and foot orthotic manufacturing markets.

The selection of spindle and tool management system; provision of effective non fluid cooling; effective removal of polypropylene (PP), ethylene vinyl acetate (EVA) and aluminium swarf; handling and clamping of EVA and PP billets; and provision of an optional fourth and fifth axis of rotation for the workpiece.

**Achievements/Description of the Design**

The design meets the brief by providing the following configurations:

General machining capability is achieved with the selection of a spindle to enable high speed machining. This enables the use of direct air cooling of the tool tip. An optional tool change unit and fourth/fifth axes of workpiece rotation unit have also been designed to allow more efficient and flexible machining.

Orthotic manufacture is accommodated through the inclusion of an air ioniser to neutralise the charged EVA swarf particles, allowing them to be effectively evacuated into a sealed collection unit, which allows safe disposal of this potentially harmful waste. The EVA and PP billets are also inserted and clamped into the machine outside the working volume and then automatically fed in, allowing safe usage by untrained users.

**Designers**

Matt Berry, Chris Davis, Thomas Edbrooke, Josh Hodges, Eloi Surply

**Supervisors:**

Prof. Stephen Newman, Dr Jason Matthews
**Design Brief**

The need to develop an energy supply for the future that is both environmentally friendly and reliable is becoming increasingly more important. Nuclear fusion shows potential to fulfil these needs, but is still in its infancy in terms of a practical solution. Experimental fusion reactors such as JET and ITER are used to develop the technology but create many problems for engineers to face. Due to radiation levels, human access is restricted within the reactors so all operations need to be completed remotely - Oxford Technologies specialise in the provision of expertise and practical solutions in remote handling applications. This project looks at a particularly challenging task of welding new lengths of pipe into the reactor in a remote handling environment.

**Specification/Key Issues**

The machine developed must prepare and weld two axially misaligned pipes together. Notable considerations include:

- Design to operate with pipes with axial misalignment up to 10°
- The machine must be operated by the remote handling manipulator
- The machine must prepare for and use TIG welding
- The procedure must be clean, leaving no trace of swarf or contaminants
- The pipe ends must align accurately when brought together, typically with 50µm tolerances
- The machine must verify the accuracy of the alignment

**Achievements/Description of the Design**

A machine has been developed which is capable of preparing the pipe ends, accurately aligning them and then completing a TIG weld whilst under the control of the manipulator. The core of the design consists of an orbital drive assembly which supports both lathe tools and measurement instruments to verify accuracy. Swarf is contained by the orbital assembly and prevented from entering the pipe bores by the provision of bungs being installed. An alignment system automatically positions the pipes symmetrically to the lathe to provide accurate alignment whilst demanding minimal user input. Clamp units secure the pipes during the procedure and then bring them together once their ends have been prepared. A TIG welding unit is then positioned to complete the weld on the join.

**Designers:**
James Faulkner, Jack Merrick,
Chris Snider, Edwin Chen,
Ahmed Bakhiet

**Supervisors:**
Dr. Derek Tilley, Dr. Nigel Johnston

**Sponsors:**
Oxford Technologies
Design Brief

The project brief invited the investigation of creating a small scale Combined Heat and Power (CHP) system using a Rankine cycle to generate heating and electricity in a domestic environment.

Specification/Key Issues

The solution was required to:
• Provide adequate hot water and space heating for the household at all times.
• Generate mains compatible electricity that can be used when required or sold back to the local supplier when not required.
• Fit into a typical domestic kitchen, replacing a conventional boiler unit.
• Safely contain high temperature, high pressure steam.

Achievements/Description of the Design

The system extracts heat and work from steam at 30bar and 350°C to generate up to 15kW thermal output and 2kW electrical output.

The cycle operates as follows:
• Water is pumped to 30bar pressure using an off-the-shelf motor driven pump
• The water is boiled and superheated to 350°C in a custom designed boiler unit with reheat facility.
• The steam undergoes a two-stage expansion with reheat in off-the-shelf scroll expanders and is then condensed in a plate heat exchanger.
• Heat is transferred during the condensation to central heating and domestic hot water circuits using a dual heat exchanger layout.
• Electricity is generated from the scroll expander outlet shaft using an alternator and is then synchronised with the mains in an inverter.

Designers:
Ylhem Hadj-Mimoune,
Duncan Mawdsley,
Matthew O'Brien,
Edward Smith,
Kian Tan, Vincent Yap

Supervisors:
Prof. Chris McMahon,
Dr Yee-Meh Goh

Sponsors: Spirax Sarco
Design Brief
To design a human powered submarine to utilise the power produced by a pilot to propel a submarine around a course. The submarine will be built during the 2009-2010 academic year and taken to the Ocean Basin facility owned by QinetiQ in Gosport. The course over which this submarine is intended to race tests the submarine's manoeuvrability and acceleration over a distance of around 120m.

Specification / Key Issues
- The rules of the competition state that a submarine is “a free flooding (liquid-filled) vehicle that fully encapsulates the occupant, and operates entirely beneath the surface of the water”.
- The submarine must be fully controllable and propelled by a single pilot.
- The health and safety of the pilot are paramount.
- Propulsion must be non-propeller.
- Must be capable of achieving a turning radius of 5m.

Achievements/Description of the Design
The shape of the hull and the orientation of the propulsion and control systems were vital in achieving a manoeuvrable submarine. The hydraulically operated rudders have been placed directly behind the bio-mimetic type, vertically oscillating fin propulsion system to ensure high speed flow over the control surfaces. The hull is tall and thin as well as being as short to further aid manoeuvrability. To allow the propulsion to be in the optimum position at the aft of the submarine, and the pilot to see the course on the bottom of the pool, the pilot must lay head first in the submarine. At his fingertips are controls to operate the rudders as well as hydraulic dive planes at the fore and aft of the submarine to provide pitch and heave control.

Designers:
- Lukman Alhakim
- Rob Holbrow
- Ben Marshall
- Helen Miller
- Jack Tommony

Supervisors:
- Dr. William Megil
- Dr. Roger Ngwompo
Design Brief

Car manufacturers are under legislative pressure to reduce the CO\textsubscript{2} emissions of automobiles to 120g/km by 2012. With recent changes to Formula 1 rules, KERS (Kinetic Energy Recovery Systems) has gained significant exposure. Mechanical Flywheel KER systems have recently become recognized as a viable means of improving fuel economy in automobiles. The aim of this project was to develop a low-cost flywheel solution that could be easily integrated into the automobile mass market.

Key Issues

If the flywheel is to be useful as an energy saving device, the energy savings from its operation must outweigh the cost of its inclusion.

Drive-cycle Efficiency - The efficiency of flywheel was optimised by directly matching its workable energy range with that required from a typical drive cycle.

Material Selection and Sizing - For mobile applications, the added weight and space requirement of the flywheel is a major concern. This was improved through appropriate material selection and compact layout.

Versatility - Layout of the product must accommodate a wide range of powertrain platforms.

Achievements of the Design

A 600 kJ energy storage capacity was achieved in a 240mm * 50mm stainless steel flywheel by spinning at speeds of up 40 000 rpm.

A compact magnetic clutch was created that allows for electronic flywheel engagement.

A novel epicyclic gear - CVT combination was developed. This reduces the demands of the clutch and minimises losses through an infinitely variable transmission.

The unique central interface of the layout allows for flexible product location.

With a conservative estimate of 50% energy savings, the flywheel should reduce CO\textsubscript{2} emissions by up to 4.7g per km. With a market value of $100 for each gram of CO\textsubscript{2} reduced, the flywheel unit is worth $470 to car manufacturers.

Designers: Richard Clarke
James Coop
Nicholas Dupré
Taylor Wanberg
Rob Wade

Supervisors: Prof. Patrick Keogh
Dr Sam Akehurst
**Design Brief**

The project is to design a smart assistive robot for dementia care. Currently there are 700,000 sufferers of dementia in the UK. This is expected to increase to 1.7 million by 2050. This disease already costs the UK £17bn per year and this is only set to rise. A possible solution is to use technology to reduce future costs. However it is important to target the product at the symptoms of the disease such as memory problems, poor judgment, spatial orientation, difficulties with everyday tasks, language problems and possible changes in mood, behaviour and personality.

The suggested robotic solution must function within close proximity with humans in a home environment that it is placed in. By taking advantage of mechanical and electrical technology this smart assistance will be adaptive, reactive and supportive. The design must provide a platform for future development and allow easy expansion. Due to the nature of the application, it is important to allow the robot to be customisable to the patient's requirements.

**Specification/Key Issues**

The key requirements of the robot are:

- Dispense medication directly to the patient
- Be fully autonomous
- Be able to navigate throughout a person's home
- Have a modular design to allow for future upgrades
- Not endanger the user in any way

**Achievements/Description of the Design**

A fully autonomous robot has been designed. Able to navigate freely throughout a patient's home, this solution will offer the customer an increased quality of life and extend the time they can spend in their own homes before requiring more intense care. Key benefits are the medication dispenser and the mechanical arm which enables the robot to be much more versatile. The full package uses simple maintainable electronics and mostly off-the-shelf components. Therefore it costs no more than £3500 to build.

**Designers:**
Department of Mech. Eng.
Stephanie Lowe    Nadia Kourra
Ching Meng Hong
Department of Electrical Eng.
Neoklis Pishiaras  William Tucker
James Morley

**Supervisors:**
Dr Pejman Iravani  Prof. Steve Culley
Dr Rod Dunn
**Design Brief**

Many types of consumer products have highly seasonal markets and fluctuating demand. With confectionary in particular, there are peaks in sales around the holiday periods of Christmas, Easter and Valentine's Day. These products are usually bought as gifts for friends and family members, so the packaging tends to be elaborate and eye catching as producers aim to use marketing to obtain advantage in a competitive marketplace.

Both of these factors mean that the confectionary packaging market is largely unstable and manufacturers need to be flexible and reactive to changes in demand and product type. It would be beneficial to introduce a form of reconfigurable packaging equipment that could help to deal with these problems.

The University of Bath completed a research project, to design a system which could be reconfigured to manufacture a number of different styles of packaging. This project successfully produced a working prototype that could fold boxes along pre-creased lines. The aim of the ARCHAPS project is to supplement these folding motions with guiding motions to ensure that box webs and tabs are located correctly during the folding process.

**Specification/Key Issues**

The key requirements of the reconfigurable packaging machine are:

- Have a modular design to allow reconfiguration of the machine between batches
- Be capable of producing one box every three seconds.
- Be reconfigured in less than one hour by an individual.
- Fit within a 2.5m square footprint.
- Production costs less than £42,500 in order to remain competitive with existing solutions.

**Achievements/Description of the Design**

A modular machine has been designed to perform the guiding motions required. A premium and standard package have been designed in an attempt to extract maximum value from the market. The premium design consists of a multi degree of freedom actuator system capable of both web guiding and tucking operations, whilst the standard package (pictured) consists of simple actuators and tucking mechanisms for the more simple packages. Both designs are capable of matching the existing throughput whilst improving upon the safety, reliability and costs currently experienced.

**Designers:**
Peter Birtles
Sam Knott
Gwion Rees
Steven Livesey
Michael Mills
Can Tiryakioglu

**Supervisors:**
Dr Glen Mullineux
Mr Rod Valentine
Design Brief

The population of the Earth is growing at a tremendous rate. There is an increasing demand to meet energy needs with more sustainable methods than traditionally used. Paddle Power was given the brief to investigate an innovative new vertical axis turbine for use in both wind and water applications. The idea was conceived by Krishnan Thampi of International Power.

Specification/Key Issues

Wind Turbine:
- Provide 25% of the annual domestic consumption of the average household; 25% x 4670 = 1170kWh
- Produce the power at a mean wind speed of 5m/s
- Priced in line with competition

Water Turbine:
- Provide enough energy for a small community such as Bradford-upon-Avon.
- Operate in an average flow velocity of 1m/s.

Achievements/Description of the Design

The Wind Turbine exceeded requirements achieving twice the required power output. This was partly due to the addition of an innovative cowling structure. The effect was to double the wind force acting on the turbine blade. In addition, the compact turbine/generator design ensured the domestic mounting required little disruption to a building's structure.

Research found it was unfeasible to design a turbine for most locations due to unsuitable river profiles. However, where installed the power output was significant. Cowling used in the design effectively doubled the effective water force from 1 to 2m/s which meant that in a flow of 1m/s the power output would be 1.30kW.

Designers: Alex Wolstenholme
Rachel Spevack
Andrew Bradbury
Peter Best
Matthew Hyland

Supervisors: Graham Outram
Dr Stuart MacGregor

Sponsors: International Power plc
**Design Brief**

Mobile elevated work platform (MEWP) manufacturers such as Niftylift produce a wide range of systems for different access applications, varying from building maintenance to tree surgery. The self propelled variant, which allows users to drive around whilst elevated in the cage, is the most popular type. Existing systems are limited to operating on reasonably flat, level terrain. The design brief is to develop a system which enables the self propelled MEWP to operate on slopes of up to 10 degrees and increase rough terrain utilisation.

**Specification/Key Issues**

- Enable MEWP operation on 10 degree slopes in any orientation
- Full working outreach to be maintained
- Must not impose on system dimensions when not in use
- System must weigh less than 300kg
- System to cost less than £1200
- System to be capable of retrofit to existing designs

**Achievements/Description of the Design**

The chosen design direction is for a system to level the entire MEWP, thus enabling the machine to operate as if on level terrain. The system consists of four independent hydraulic stabilisers which are mounted one on each wheel. These stabilisers are used to raise the machine off the ground, with the levelling being achieved by raising certain stabilisers further.

**Designers:**
Christine Akrofi    William Bickell
Gethin Holloway    Kok Rong Ng
Alexander Storton

**Supervisors:**
Dr. J. Vogwell
Mr. M. Hinds

**Sponsor:**
Niftylift
**Design Brief**

The topic of assessing patient functional outcomes after orthopaedic interventions is becoming increasingly important. Traditional scoring systems used to evaluate postoperative results do not necessarily reflect the functional outcome achieved by the patient. The design of equipment that could be integrated into a hospital or clinical environment to facilitate pre- and postoperative functional assessment and provide quantitative rather than qualitative measurement would be a great asset.

**Specification/Key issues**

The **BUJE System™** range of products should satisfy the following criteria:

- **Accurately measure** flexion/extension of the knee and hip
- Accurately measure abduction and possibly adduction / rotations of the hip
- Offer simple operation for a qualified physiotherapist or occupational therapist, following basic introduction and training
- Simulate key daily activities such as negotiating stairs, walking up and down slopes, getting in and out of public transport
- Evaluate patient performance with a quantitative scoring system and provide each patient with a final numerical evaluation score.

**Achievements/Description of design**

In order to effectively and accurately evaluate the outcome of the procedures, it was decided that the system be split into three categories:

- Clinical Data Measurement
- Daily Activity Simulation
- Movement studies

Three devices were developed in order to fit the need of each of these categories: a Range of Motion measurement device, an Adjustable Stairs & Chair unit and an Adjustable Ramp. Each device is accompanied by a score sheet that is to be filled in by the physiotherapist conducting the testing, and the patient is given a final score based on their performance.

**Designers**


**Supervisors**

Prof. A. Miles
Dr Sabina Gheduzzi
Robin Long
Rowing Bicycle

Design Brief

The project is to design a bicycle that may be powered by a rowing as opposed to a pedalling motion. The device will be used as a leisure aid by recreational users but with an excellent replication of the rowing motion it may also be used as a great training aid for budding rowers.

Specification/Key Issues

- Product should be as stable as a recumbent bike.
- Product should be as stable as a recumbent bike.
- Weight of a two wheeled solution should be below 18kg, Weight of a three wheeled solution should not exceed 21kg.
- The product must have a unique element within its design.
- Bicycle components should be utilised where possible.

Achievements/Description of the Design

The final product is a single user tadpole tricycle. i.e. there will be two wheels at the front of the wheel and one at the back, this allows for great stability and good dynamic handling characteristics. The user is seated in a fixed position towards the rear of the trike and both their hands and feet move relative to the seat to perform the rowing motion. The product is steered by handlebars and is supplied with a full compliment of mountain bike gears and rugged disk brakes to create a very versatile product.

Designers:
- Adam Hicks
- Charles Parr
- Ross Woodrow
- David Stevens
- Lucy Ferguson

Supervisors:
- Dr Jos Darling
- Mr Tim Holsgrove
Design Brief

The ball launching market is relatively small, with only a few major manufactures of devices capable of producing replicable ball flights in sport. The boot to ball contact and leg swinging motion seen in competitive sport has only been addressed by a small number of research institutions and consequently only single, one-off production items have been produced that have had very limited success. This has therefore provided Soccer Shooter with an opportunity to take advantage of this in the market, to design and produce such a device on a larger scale. A device is required that can accurately portray all football kicks performed in soccer and all the boot-ball contacts experienced during the professional game.

Specification/Key Issues

The product must replicate the human kick where there is contact with the ball and create the resultant accurate ball flights as seen in the professional game. This to allow testing for boot and ball manufactures/research institutions and to allow creation of ball flights for football training.

Achievements/Description of the Design

The designed product not only satisfies the specification requirements initially set out but exceeds them in many cases.

The unique power system behind the creation of the force has been designed to allow all of the desired leg velocities to be created which in conjunction with the effective mass of the swinging prosthesis will create all desired ball velocities seen in the professional game.

All leg swings of professional footballers that are used in regular soccer can be produced with a range of foot positions allowing accurate reproduction of all types of kick.

Designers: James Dick, Ali Gregory, Christopher Lovett, Stuart Powell, Max Taylor

Supervisors: Prof. Alan Bramley, Dr. Ken Bray
Design Brief

The project concept is to design a single-seater racing car and submit the design for the assessment in the IMechE organised annual Formula Student event. At the competition, the team will be judged on: design, costing and presentation.

“For the purpose of the competition, the students are to assume that a manufacturing firm has engaged them to produce a prototype car for evaluation. The intended sales market is the non professional weekend autocross or sprint racer. Therefore, the car must have very high performance in terms of acceleration, braking, and handling qualities. The car must be low in cost, easy to maintain, and reliable.

The challenge to the team is to design and fabricate a prototype car that best meets these objectives. Each design is compared and judged with other competing designs to determine the best overall car”

Specification/Key Issues

Team Bath Racing 2010 has come to the conclusion that in order to be competitive in Formula Student the car must be lightweight, low compromise and innovative. It is a direct requirement of the customer that the car must be competitive and of high performance. As a restriction on engine size (610cc) and breathing (Ø 19mm air restrictor for E85 fuel) caps engine power, the best way to increase performance is to reduce the weight of the vehicle. This year's strict weight target is 230kg, including the driver. This is to be achieved by the extensive use of carbon composites on the chassis and wheels; and the radical change to a supercharged single cylinder engine, a first for any Bath Formula Student team.

Achievements / Description of Design

The final specification for the car that is to compete in Class 3 of Formula Student 2009 includes:

- Supercharged, 505cc single cylinder engine running on E85 fuel
- Carbon composite monocoque with tubular steel rear subframe chassis
- Custom full carbon composite wheels and drive shafts

Project Manager: Tanmay Dube
Chassis Team Manager: Rob Sciacaluga
Powertrain Team Manager: Ian Tipple
Designers: Hirzi Amirrudin, Seb Bonizzi, Xiaoshi Chen, Kim Gan, Sam Guest, Yue Huang, Cyrus Li, Christina O'Sullivan, Andrew Parker, Vasileios Trantopoulos, Sam Skipper,
Supervisors: Dr Geraint Owen, Dr Kevin Robinson
Sponsors: Accenture, Andy Robinson, Race Cars, The Bugatti Trust, Castrol, CP Engineering, Cummins, Deloitte, Ricardo, Royal Navy, Perkins Engines Co Ltd,
Aeronautical Projects

Supervisors

*Academic*
- Dr R Butler,
- Dr M Wilson
- Dr J. L. Cunningham,
- Dr H A Kim,
- Prof I Gursul,
- Dr G D Lock,
- Dr M J Carley,
- Dr D G Tilley,
- Dr J Vogwell,
- Mr R G Outram
- Dr D N Johnston,
- Prof S. T. Newman

*Industry*
- Prof J. Jupp,
- Mr P. Chapman,
- Mr T. Engelbrecht,
- Mr D. Heaton,
- Mr K. Macgregor,
- Mr M. L. Jukes,
- Sir Robert Hill,
- Mr R. Holliday,
- Dr J. Crocker,
- Mr M. Ball,
- Mr A. Landridge,
- Mr C. Stevens,
- Mr N. White

*Sponsors:*
- Airbus UK, Rolls-Royce
Design Brief

Commercial passenger aircraft have traditionally been designed for non-stop point-to-point operations. However, suggested by the Greener By Design committee, significant fuel saving could be achieved by flying long range multi-stop instead of non-stop operation. A fuel saving would decrease the direct operating costs and reduce the ticket prices which would appeal to the airline operators as well as the passengers.

The aim of this project is to design a medium size aircraft optimised for multi-stop operations. The existence of the B787 and A350 have proved the potential market for medium size aircraft and the proposed aircraft in this project would penetrate this market using its low direct operating cost, with an entry into service date of 2020.

Specification/Key Issues

- Passenger Capacity (2-cl LR): 250
- Design Range: 2000 - 5000nm
- Study Mission: LHR SIN
- Design Cruise Speed: Mach 0.75 - 0.85
- Take-off length/Landing length: 2800m / 2200m
- Airport compatibility limits ICAO code 'E'
- Direct operating cost reduction target: 15%

Achievements/Description of the Design

The Kangaroo K250 is a low wing, conventional design with a capacity of 252 passengers including 36 seats for first class and 216 seats for economy class. The design range of the K250 aircraft is 3400nm which covers most of the cities in the world within one stop such as Heathrow to Singapore. An extra set of flight and cabin crew would be brought onboard during a one-stop long-range flight. They will work in shifts in order to fulfil the FAR25 requirements. The MTOW of this aircraft is 151 tonnes and the OWE is 89 tonnes. The overall length and wing span are 55.95m and 50.46m respectively. The aircraft cruises at Mach 0.82 with an initial cruises altitude of 36,000ft whilst expecting a service ceiling of 40,000ft. The extensive use of composite materials in the fuselage and wing reduces the structural weight of the aircraft and eventually reduces fuel burn. Traditionally, the wing area is designed to be larger than required for future family development. However, it also increases the weight of the aircraft, the size of the engine, the lift to drag ratio and eventually the operating cost. Therefore, for future development, instead of using a larger wing, the aircraft will decrease its operation range to compensate for the increase in passenger capacity. This optimisation results in reduction of both DOC & COC compared to future non-stop aircraft with savings increasing significantly with fuel price increases.

Designers:

Gary Ho, Matthew Fortune, Nicholas Withers, Andrew Tuck, Richard Wood, Jaisal Patel, Rory Hunter, Shreyas Reddy, Kenry Chen, Gary Nam,
Long-Haul Multi-Stop Commercial Aircraft Team B

Design Brief

Current commercial aircraft typically fly long-haul routes non-stop. Research by the Greener by Design committee has indicated that if the same long-haul route were to be flown in two-stages, refuelling en-route, fuel savings could be achieved. Operating existing aircraft in this way could result in some fuel savings, but the Greener by Design committee suggest much greater savings could be made if an aircraft were to be designed specifically for such a multi-stop operation.

The task proposed by the University of Bath and Airbus UK was to design an aircraft optimised for multi-stop operations, capable of competing with current mid-sized non-stop long-range aircraft such as the Boeing 777. The design driver is fuel economy, resulting in a low aircraft weight at take-off, and reduced costs to operators and passengers.

In addition to meeting all regulatory, economic and environmental needs of operators for an intended entry into service of 2020, the aircraft must be capable of:

- Transporting 250 passengers in first and economy class, and their associated baggage.
- Cruising at a Mach number between 0.75-0.85 at an altitude between 33000-37000 feet.
- Taking-off at sea level (ISA+15) within the required field length of 2800 metres.
- Landing at sea-level within the required field length of 2200 metres, at an approach speed of no greater than 150 knots.
- Meeting airport compatibility code E.
- Achieving ETOPS 180.

Achievements/Description of the Design

The design is of conventional configuration with a maximum take-off weight of 148 tonnes, wingspan of 48 metres and overall length of 58 metres. The aircraft is capable of transporting 250 passengers, 9 cabin crew and 4 flight crew in long-haul comfort over a design range of 3500 nautical miles. The aircraft climbs to its initial cruise altitude of 37000 feet in under 25 minutes, after which it cruises at Mach 0.83. The aircraft is optimised for quick turnaround at the re-fuelling stop, ensuring minimal increase in the total journey time compared to a non-stop operation. The optimised design, use of composites and fly-by-light technology coupled with expected improvements in future air traffic management procedures ensures the aircraft presents a near 15% fuel saving over the nearest competitor, the Boeing 787-800. Direct operating cost savings of up to 10% are predicted, indicating that the aircraft and operating procedure, whilst being environmentally friendly, is also economically viable.

Designers:
Tim Francois Hugh Blakemore
Robert Dunn Stefano Matussi
John Mitchell Shukri Mohammed
Jamie Bryson Patrick Stubbs,
Chris Leung Kong Zing
Christopher Burnside
**Design Brief**

The environment is a large concern for the aerospace industry and savings in fuel burn can save air operators substantial amounts of money as well as having benefits for the environment. The idea of doing long-haul flights, but in more than one step, has been suggested as a way of reducing fuel burn, as the aircraft will be lighter, as it would have to carry less fuel for each stage. The brief was to design a 250-seat aircraft (in a 2 class configuration) for such a purpose, with the design mission being London Heathrow to Singapore Changi. The number of stops en-route was not specified.

**Specification/Key Issues**

The specification given stated that the aircraft must:

- Carry 250 passengers in a 2-class configuration (first and economy classes).
- Have a range of between 2000nm and 5000nm.
- Cruise at a Mach number between 0.75 and 0.85.
- Be able to takeoff at sea level at a temperature of 30°C in less than 2800m.
- Be compatible with ICAO Code 'E' requirements.
- Be suitable for an entry into service date of 2020.

A key issue throughout the project was how many stops to do, as this was not set. The efficiency and costs of doing the extra stops also had to be considered to see if the aircraft was economically viable.

**Achievements/Description of the Design**

The Skyhopper design is a low-wing design with rear-mounted engines. The engine position allows the landing gear to be shorter, which significantly reduces noise on approach, weight and running costs. As the engines are not mounted on the wings the wing is 'clean' and so is more efficient.

The Skyhopper can carry up to 252 passengers with 36 in first class and 216 passengers in economy class. The aircraft has a maximum takeoff weight of 162 tonnes and is designed to cruise at a Mach number of 0.85. On the design mission Skyhopper stops once in Dubai, however there are also alternatives available. For this Skyhopper has a range of 3240nm, which also allows trans-Atlantic routing. Skyhopper is powered by two Rolls-Royce engines each producing 56,000lbf of static sea-level thrust.

Skyhopper is compatible with ICAO code 'D' requirements, which means that it is compatible with a lot of airports, as ICAO code 'D' is smaller than ICAO code 'E'.

**Designers:**

Philip Hallen, Robert Buck, James Chew, Nuno Fragoso, Daniel Scarfe, Jonathon White, Sicong Wang, Tim Paice, Pamela Charatpotiratananaku, Mohammed Albassam,
The handling and packaging of tolerance rings

Design Brief

To combat the environmental impact of the aviation industry, airplane manufacturers are looked upon to reduce emissions and noise in their next generation aircraft. Despite consistent growth in the number of air passengers (Air traffic to at least double in next 15 yrs, average 6% growth in traffic per year) the industry is called upon to reduce its carbon footprint. The most effective way of reducing emissions is to reduce the fuel burn by operating an aircraft optimised to fly long range journeys in two or more hops refuelling along the way. Not having to carry the fuel for the entire journey could produce significant fuel savings for such a design against a comparable aircraft flying a non-stop journey. This idea has been proposed by the Greener by Design committee with a specification from Airbus for the UB2009 Aerospace Group Business Design Project.

Specification/Key Issues

With an EIS of 2020 the aircraft must have:

- 250 Passenger Capacity (2 class)
- 2000-5000nm Design Range
- Cruise Speed Mach 0.75 0.85
- ETOPS 180 Certification (at EIS)
- Long Range facilities and comforts
- FANS Capable Flight Deck
- Noise target: Stage 3 minus 25
- EPNdB.
- 40% margin to CAEP6 for NOX, CO, Hydrocarbons and Smoke

The Key Design Drivers are:

- Minimum Fuel Burn vs. Non Stop Reference DOC no worse than non-stop reference
- High Cycle Operation
- Capable of Refuelling at less equipped airfields
- Trans-pacific/Trans-Atlantic capability

Achievements/Description of the Design

The design team of the persona company 'Airex' have designed a conventional configuration, wide body, twin engine aircraft of design range 3500nm with a capacity of 250 passengers in 2 classes designed for refuelling en-route

The design solution, the Airex D250 cruises at Mach 0.82 with a wing span of 48.84m, and an overall length of 58.53m. It has a Max. Takeoff Weight (MTOW) of 156t with two Rolls Royce power plants providing a static thrust of 54068 lb per engine.

It has somewhat smaller wings than aircraft that would fly comparable routes (up to 7000nm) leading to reduced fuel burn and greater efficiency over rival aircraft.

The design also has scope for stretch and shrink variants of +/- 20% payload.

Designers

James Upton,
Hoi-Man Jim,
Howard De Podesta,
Benjamin Megson,
Zhipeng Fu,
Keita Kalomba Mboyi,
Sin-Cho Chan,
Priyesh Patel,
Amelia Wong
Assunta Cheng,
Design Brief

The brief for this year's Aerospace Group Business & Design Project was to design a 250 seat passenger aircraft that would perform a multi-stop flight to its destination. The design mission was from London Heathrow to Singapore with at least one stop en route. This is based on the 'Greener by Design' study which examined the theory that multi-stop aircraft could potentially burn less fuel and therefore produce less harmful emissions. The entry into service for this aircraft will be 2020, when the ACARE 2020 targets will be met. These targets challenge aircraft to half their noise, half their CO₂ and reduce their NOₓ by 80%.

Specification/Key Issues

The key factors that were taken into account in the design were:

- 250 seats
- Optimised for multi-stop mission
- ICAO code “D” compatibility
- Design Cruise Mach 0.75 - 0.85
- Design Altitude 33,000 ft 37,000 ft

The objective was to achieve these key specifications whilst keeping fuel burn, emissions and costs, both operating and production, to minimum.

Achievements/Description of the Design

The E-252 Ardea aircraft is a conventional low wing twin engine aircraft designed with the passenger in mind. It has been designed for a range of 3500nm and optimised for multi-stop missions for long range flights. It has global capabilities with transpacific capabilities. By using the latest technology, it has been possible to minimise weight of the structure by using composite materials and by using state of the art Rolls-Royce turbofan engines better fuel burn and lower emissions were obtained. The maximum take-off weight is 147 tonnes and the aircraft cruises at Mach 0.82 at 35,000 feet. The cabin has been fitted out with the latest in In-Flight-Entertainment features and the cockpit with the latest glass cockpit and avionics systems.

Designers:

J. Spargo, D.Goodfriend,
S.Hua, C. Lopez,
P. Batten, L. Bowler,
J. Ho, Y. Lalwani,
P. Nannini,
G.P.Malfense-Fierro
Project Sponsorship 2008-2009

Our most grateful thanks and acknowledgements are due to the companies listed below for proposing and sponsoring this year's design projects. The financial support and equipment which they have provided have been crucial to the success of the projects, and the encouragement and insight of their staff have been highly valuable to our students.

Niftylift
Spirax Sarco
International Power plc
Oxford Technologies
Airbus Filton
Rolls-Royce
Race Cars
Cummins
Andy Robinson
Royal Navy
Castrol Consumer
Perkins Engines Co Ltd
Ricardo Engineering
The BUGATTI Trust
Deloitte
Accenture
CP Engineering

The Smallpeice Trust
http://www.smallpeicetrust.org.uk

We continue to acknowledge the contribution of the Smallpeice Trust who for many years have funded a Design Prize. More importantly they enable the Design Projects to be externally assessed by Senior Engineers from Industry. This acts as an invaluable quality and reality check. The considered feedback from the assessment teams over the years has been invaluable.
**Integrated Industrial Projects (IIP)**

The Integrated Industrial Project is a design-based project undertaken in local industry over a six-month period from March to August.

Typically around ten third year students choose this option each year instead of the full time group design project.

Due to the timing, they do not exhibit their work at the Design and Project Exhibition.

This year's IIP Students are:

**United Kingdom**

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<thead>
<tr>
<th>Student</th>
<th>Company</th>
<th>Supervisor</th>
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<tr>
<td>Tom Blackmore</td>
<td>Rolls-Royce</td>
<td>GDL</td>
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<td>Jonathan Carlin</td>
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<td>Jonathan Cherry</td>
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<td>James A Gopsill,</td>
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<td>Robert Harding</td>
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<td>Simon Harper</td>
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<td>Virginie Lacrosse</td>
<td>Talon,</td>
<td>GWO</td>
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*Sydney Australia*
2009 Engineering Projects
Undertaken at the University of Bath
Design, Manufacturing and Materials Group

James Cherrill  Supervisor: Mr Rod Valentine

Tennis racket analysis
Tennis is now an increasingly faster game, due to players becoming stronger and faster, and also to improving racket technology. This project looks at measuring string performance and the vibrational effects of strings on impact. It looks at a range of areas: maximum deflection, effect of ball velocity and response of the strings after impact. It was concluded that the designed method of measuring deflection was accurate, and gave comparable results to previous studies.

Keith Fry  Supervisor: Dr Ben Hicks

Investigating the functional demand of a vacuum cleaner during a typical use cycle.
Information on the functional demand of vacuuming (the posture of the user and the forces that they have to apply to use the product) is required as part of an inclusive design project investigating household products. A methodology is proposed and followed to investigating the contact forces applied by a user during the most common actions performed when vacuuming and for investigating the effect vacuum cleaner design parameters have upon these user interaction forces.

Peter Glacken  Supervisor: Dr Ben Hicks

Improving the Kerbside Recycling Process by the Application of Lean Thinking and Ergonomic Kerbside sort recycling collections systems currently provide high quality recyclable materials and high yields, they are however very inefficient. This project aims to improve the efficiency of the system in Bath and North East Somerset by applying the principles of lean thinking and ergonomic design. This is achieved by performing a data collection activity on the system and analysing the results to identify wastes and ergonomic aspects to create a set of recommendations for improvement.

Paul Griffin  Supervisor: Dr Linda Newnes

End-of-life costs of electrical and electronic equipment
In the age of extended producer responsibility legislation, e.g. the WEEE (waste electrical and electronic equipment) directive, and environmentally conscious consumerism, manufactures of electrical and electronic equipment (EEE) are facing up to the cost of their products from conception through to end-of-life (EoL). In this project, a novel approach to predicting EoL costs of EEE was developed. This model can be applied to all the major EoL recovery process options, e.g. remanufacturing and recycling.

Ilya Gribanov  Supervisor: Prof. Paul Maropoulos

Design for reconfigurable assembly platform for aerospace composites
The author of this project works in co-operation with the University of Bath Laboratory for Integrated Metrology and Assembly towards designing a demonstrator model of an automated reconfigurable, non-contact metrology assisted assembly cell. His specific task was designing a low accuracy 3 axis of movement machine with a large working envelope, which was to transfer a high accuracy 3 axis of movement assembly machine with a small working envelope around the assembly area.

Kavish Gupta  Supervisor: Prof. Steve Newman

Feasibility study of 4 axis CNC machine of a shoe last
The current market trends towards personalized products have seen new demands made on manufacturing processes and particularly production with CNC machines. This particular project provides a novel approach to machining one such product known as shoe last by using CAD/CAM/CNC methodology. It proves that it is feasible to generate a shoe last by this procedure more effectively and efficiently than the conventional method.

Robert Halsall  Supervisor: Prof. Steve Culley

A "social bookmarking" approach to managing engineering information and knowledge
This project aims to research and understand knowledge management theory and techniques, and the fast changing world of social media. It then aims to go further, discussing the possibilities of social media use in engineering methodology, and the benefits that the use of such platforms may have. Concluding with a brief specification of requirements; a social media approach specifically for the engineering sector, to assist in knowledge and information management (KM).

Herve Hilaire  Supervisor: Prof. Steve Culley

The 21st Century Book" project (DMM 22)
“21st Century Book project has for ultimate aim to develop a methodology to design adaptable e-textbooks for a variety of applications. This initial phase consisted in exploring and understanding user needs, reviewing the available technology, suggesting novel formats and investigating the value of document decomposition. A sample based on a large set of course notes was produced and tested on students. The work performed lays the ground for further research and applications.”
Leehard Hoerauf  Supervisor: Prof. Paul Maropoulos

Integrated Design, Manufacture and Verification of High Precision Parts.
There are several processes available for the manufacture of designed components. This report looks at two methods, integrated machining and manual milling, and compares their respective performance in the context of manufacturing two highly tolerated components for assembly. The integration of automation in modern manufacturing and measurement systems is analysed. Additionally, the transition from the design stage to manufacturing and the importance of constraints placed on designs by manufacturing and constant measurement capabilities are examined.

Rhys Jones  Supervisor: Dr Adrian Bowyer

"New RepRap Materials"
The RepRap project aims to create a rapid prototyper, which is able to produce all of its own components. The aim of this project was to develop an extruder for RepRap, to enable it to deposit new materials other than the thermoplastics it was able to utilise at the start of the project. The project culminated in development of a technology to allow the deposition of electrical solder, enabling RepRap to manufacture electronic circuit boards.

Tomas Keaveny  Supervisor: Rod Valentine

CAD Modelling and analysis of a tennis racket
This project uses analytical methods to improve the understanding of the stiffness of a tennis racket, beyond the RA index given in racket specifications. A model of the Prince Original Graphite racket was produced in a CAD package and converted into a finite element mesh, then analysed to demonstrate the influence of various contributing factors. These include the use of different materials, designs and loading conditions, and also the affect of strings.

Peter Kermack  Supervisor: Dr Ben Hicks

Sealing jaw design
Sealing jaws used for packaging in vertical form fill and seal operations are commonly used but not well understood pieces of equipment. A literature review, thermal modelling and pressure film tests were carried out to expand the knowledge of the sealing operation, also, a sealing jaw with interchangeable profiles was designed in order to compare the effectiveness of these different profiles in a fair test.

Stephen Laker  Supervisor: Dr Elies Dekoninck

Developing a carer’s interface for the autonomous home
Dementia is a condition which cannot be cured, only slowed down; therefore assistive technologies stand to play a key role in helping sufferers retain a quality of life. The Bath Institute of Medical Engineers pioneer assistive technology and their smart home in Bristol provided the base for this project. By examining data and interviewing carers, the project created a software specification for an interface at the smart home, giving carers access to data recorded.

Chris K Z Leung  Supervisor: Prof. Steve Culley

Enhanced lessons learned approaches for industry
The aim of this project is to enhance current Lesson learned approaches in different sectors of industry. The phrase “Lesson have been learned” is commonly used on TV and radio, but have lessons been really learned? This project discusses the key requirements of a Lesson learned report, how this will affect a company’s efficiency in the long run and possible improvement to overcome this problem.

Ivan Tsz Yu Li  Supervisor: Prof. Chris McMahon

Demand Responsive Air Transport
This is a research project on the viability to implement demand-responsive air transport (personalized flight with flexible time and place) in order to reduce emission and provide passengers’ friendly service. Possible solutions to the main difficulties of DRAT (scheduling problems and changing connection flights to direct flights) were figured out from the study of existing procedures in flight scheduling, load factor concerns for connection and direct flights and estimated fuel consumption by different airline services.
Min Liang  Supervisor: Prof. Paul Maroulos
Development in mobile robot navigation using indoor large volume metrology system
In this project, experiments are carried out to investigate the feasibility of mobile robot navigation using indoor large volume metrology system, and also explore the repeatability of the robot. Then use this technique to measure the shape of an irregular surface and construct it in a computer.

Amanda Park  Supervisor: Prof. Glen Mullineux
Seal integrity testing machine
The seal integrity of flexible packaging is an extremely important factor in maintaining product quality. Food manufacturers have resorted to using a manual squeeze test to determine seal integrity, rather than using the costly, accurate tests available. This report studied the feasibility of automating the manual squeeze, using crisp bags with pinholes and channel leaks. It was found that an Instron can detect and estimate the size of holes, thus subsequent machine designs are discussed.

Shuai Liu  Supervisor: Dr Ben Hicks
Investigating the use of Ultrasonics for Sealing and Cutting in high speed packaging systems.
This project investigates the use of Ultrasonic Technology for thermoplastic welding in various industrial applications. A structured Design Methodology was developed for ultrasonic horns used in thermoplastic welding applications, which covers four main types of horn profiles and provides a guideline for selecting other components in an ultrasonic system. A case study on a Vertical Form/Fill/Seal packaging machine was used to apply and validate the methodology.

Phil Parkes  Supervisor: Dr. Aydin Nassehi
Development of a Turn-Mill Centre using a Novel Implementation of a Parallel Kinematic System
This project analyses a novel implementation of a parallel kinematic system within a compact and low cost, turn-mill centre. To ascertain the suitability of the parallel kinematic system for this application, a CAD model of the device was created. Typical loads from turning and milling operations were applied to the model and FEA analysis was conducted in ANSYS. Stiffness and deflection maps were generated and compared to existing work on similar products.

Sugnesh Patel  Supervisor: Mr Graham Outram
Analysis of Work Content - Labour Content Of A Loaf Of Bread
Individual well being requires a number of services which play a vital role in satisfying our needs and aspirations. How these needs are achieved in terms of economic welfare has minimal impact. How can we conquer individual well being and not lead such a stressful life? By understanding how much effort it takes to achieve a reasonable quality of life we can determine the total man hours needed to fulfil our basic needs and aspirations.

Jason Malone  Supervisor: Graham Outram
Design of selection fluid mixer valve
The design of a valve which allows for selection from a number of mixer liquids, which are combined with a base liquid and pour as a single mixed stream. The valve can be housed within a variety of cases and is designed to remove contamination of mixer liquids between uses.

Georgina Mann  Supervisor: Prof. Steve Newman
Design of a bespoke insole for women’s lacrosse boots
The aim of this project was to design and manufacture a customised insole for female lacrosse players; it should correct any biomechanical defects, improve efficiency and reduce the risk of injury. A 3D laser scanner, Computer Aided Design and Computer Aided Manufacture were all utilised for the design and manufacture of a bespoke insole. Cryogenic machining was used successfully to produce an ethylene-vinyl acetate symptom specific insole for the author.

Leonardo Mattioli  Supervisor: Dr Geraint Owen
Measurement System Integration for Scanning of Complex and Large Scale Components
An extensive literature review was undertaken to research what current technologies are available to industry requiring large volume dimensional measurements. A case study was then carried out with the main objective of combining data from a FARO laser tracking system with that of a Minolta Laser scanner. The large component in question was a section of an aerofoil and the proposed data integration method was successful in producing a parametric model of the wing piece.

Tanja Schumacher  Supervisor: Prof. Steve Newman
Comparison of CNC Programming Systems
Shopfloor programming systems (SFP) are used to programme CNC machines with a graphical user interface. They are run directly on the machine controller so that they are more flexible and for simple components also faster compared to the offline CAx chain. To this day it is not possible to use several SFP systems on one machine as they are not exchangeable. As every programming system has different advantages they are analysed to create a standardised approach for the selection of the most suitable SFP system for the production
**Andrew Boland**  
**Supervisor:** Mr Andrew Green  
**Application of CNC Manufacturing Techniques to Components used on a Formula Student Car.**

Computer Numerical Controlled (CNC) manufacturing plays an important role in producing components used on a Formula Student Car, such as suspension uprights, and moulds used in laying up composite components. This Project describes the application of CNC manufacturing techniques to the Team Bath Racing (TBR) 2009 car, and explores ways to create cost savings, reduce manufacturing time and utilise 5-axis machining capabilities. It also provides guidance for future TBR use of CNC manufacturing.

**Edward Chappell**  
**Supervisor:** Dr Chris Brace  
**Engine Calibration Using In-Cylinder Pressure Data**

Cyclic variability in combustion can reduce significantly, the power output and driveability of gasoline engines. Cyclic variability was investigated on a Honda CBR600RR engine by recording the in-cylinder pressure over 1200 cycles at 8 air/fuel ratios. Phase-lag plots showed determinism for rich and lean fuelling, with minimum variability at slightly rich fuelling. A method is presented for predicting the heat released per cycle based on the previous cycle and this correlated well with experimental data.

**Jonathan Corrin**  
**Supervisor:** Dr Michele Meo  
**Optimisation of a Formula Student Chassis through the use of Composite Materials**

New additions to the 2009 FSAE rules have had a significant impact on the design of the 2009 Team Bath Racing Formula Student chassis and as a result the weight increased and the torsional rigidity dropped. In an attempt to increase the performance of the space frame, a number of techniques involving composite materials such as carbon fibre skins, and composite tubing are analysed using FEA software and physical testing to recover the lost stiffness.

**Hasmit Shukla**  
**Supervisor:** Jason Matthews  
**Flying crisps**

This report was commissioned to examine the aerodynamic processes governing the flight of potato crisps during packaging in a VFFS machine in order to optimize current machinery and reduce failure rates caused by trapped product. Based on theory and practical data it was shown that larger discs could be modeled using simple equations of motion whereas smaller discs were more chaotic during freefall and thus had more complex flight profiles.

**Daniel Stirk**  
**Supervisor:** Prof. Steve Newman  
**A feasibility study into practical techniques to measure power usage during machining**

This project aimed to assess the feasibility of measuring the power usage of a three phase milling machine, to such an accuracy that would enable useful analysis of the effects that changing key machining parameters has on power consumption. The results found that changes in cutting power were largely masked by inaccuracies in the measurement techniques, and by the residual power consumption of the machine, which was far greater than the cutting power.

**Jolyon Walters**  
**Supervisor:** Dr Donny Osman  
**Energy Dissipation Device Design and Theoretical Investigation Using UREAD Technology**

Research was conducted into Universal Reusable Energy Absorption Device (UREAD) technology. This technology allows an energy dissipation device to be designed that is reusable and passive. A formula was devised using the Upper Bound analysis technique to model equal channel extrusion in 3 dimensions.

A small scale energy dissipation device was designed and manufactured. The device was shown to significantly reduce reaction forces and elastic vibrations associated with shock loading.

**Richard Ward**  
**Supervisor:** Aydin Nassehi  
**Alternative Manufacturing Techniques for Laptop Computer Casings**

Consumer demands are forever changing, forcing laptop manufacturers to provide laptops of varying specifications, causing material and manufacturing methods used to develop with this shift in demand. This project researches alternative manufacturing techniques, and then further compares the most popular method of injection moulding with the very new method of manufacturing laptops from a solid billet of aluminium. The feasibility was assessed, monitoring the flexibility, costs and environmental impact of the process.

**Formula Students Group**

**Andrew Boland**  
**Supervisor:** Mr Andrew Green  
**Application of CNC Manufacturing Techniques to Components used on a Formula Student Car.**

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Cyclic variability in combustion can reduce significantly, the power output and driveability of gasoline engines. Cyclic variability was investigated on a Honda CBR600RR engine by recording the in-cylinder pressure over 1200 cycles at 8 air/fuel ratios. Phase-lag plots showed determinism for rich and lean fuelling, with minimum variability at slightly rich fuelling. A method is presented for predicting the heat released per cycle based on the previous cycle and this correlated well with experimental data.

**Jonathan Corrin**  
**Supervisor:** Dr Michele Meo  
**Optimisation of a Formula Student Chassis through the use of Composite Materials**

New additions to the 2009 FSAE rules have had a significant impact on the design of the 2009 Team Bath Racing Formula Student chassis and as a result the weight increased and the torsional rigidity dropped. In an attempt to increase the performance of the space frame, a number of techniques involving composite materials such as carbon fibre skins, and composite tubing are analysed using FEA software and physical testing to recover the lost stiffness.
**Harry Cubbage  Supervisor: Dr Geraint Owen**

**Modelling and experimental investigation of chassis set up parameters**
The purpose of this project was to investigate the effect of chassis setup parameters on the dynamic performance of a Formula Student car with the aim of developing an optimised vehicle setup for use at the Formula Student competition. Computer simulation was used to model the effect of wheel angle, steering geometry and tyre pressure under a range of track conditions and vehicle demands. Validation of simulation results was achieved through experimental testing of a formula student car.

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**Peter Hancock  Supervisor: Dr Kevin Robinson**

**Optimisation of a transmission system**
This project focused on optimising the transmission system of the latest formula student car, TBR09. The car has been designed to use a 600cc Honda motor bike engine. This engine has an onboard six speed gearbox. A chain type final drive with a ratio of 1:3.08 was identified as the best system to use with the stock gearbox. The performance and drivability of the car could be improved if the 2nd gear ratio was changed.

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**Peter Elliott  Supervisor: Dr Kevin Robinson**

**Engine cooling and lubrication systems**
This semester I have been looking at the cooling and lubrication systems for the Formula Student car. I performed a number of experimental tests looking at the position, size and angle of the radiator. It was found that a thin radiator angled forwards provided the best balance between cooling effectiveness and a lightweight system. This investigation also looked at the design of a low profile sump to lower the centre of gravity of the car; this was aided by FEA.

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**Ashley Ellison  Supervisor: Dr Chris Brace**

**Transient Engine Calibration**
The aim of this project was to conduct transient engine calibration work on a Honda CBR600RR engine to be installed in the TBR09 Formula Student car. A good transient calibration is vital to ensure that power and torque are delivered in a smooth, predictable manner. The final calibration was shown to improve the transient performance of the engine as the air fuel ratio fluctuations were significantly reduced during rapid throttle changes.

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**Denis Gorman  Supervisor: Dr Sam Akehurst**

**Modelling & Testing of Variable Length Intake Runners**
"Engine intakes can make use of pressure wave resonance to increase performance. The potential benefits of variable geometry inlet runners to maximise this effect were investigated through simulation and experimentation, with a view for use on a Formula Student car. Substantial gains were found in both peak torque and performance across the engine speed range. The accuracy of the team's engine simulation model was analysed. Large discrepancies exist, and further work to validate the model was recommended."

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**Will Lowe  Supervisor: Dr Geraint Owen**

**A study of engine lightening**
This project looks at the effect of reducing powertrain inertia on the acceleration characteristics of the TBR09 Formula Student car. The work was done using an Excel model, in order to model the acceleration of the car and then to model it with reduced powertrain inertias, in order to find out the possible benefits. This was undertaken with a view to implementing some the ideas that proved effective on the TBR09 car.

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**Kenan Mustafa  Supervisor: Dr Kevin Robinson**

**Modelling & Experimental Study of a FS Car Braking System.**
Currently no method exists to perform thermal based design of Formula Student (FS) car brakes, or a method of exploring the effect of brake loads on components in close proximity. An experimental study focused on gaining an idea of the heat distribution within a FS car wheel and understanding how heat is dissipated. An FE model was built, verified by the experiments and allowed for the temperature of a carbon wheel rim to be predicted.

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**Farian Pillay  Supervisor: Mr Andy Green**

**The Design and Manufacture of Carbon Composite Wheels -- FS186**
This project details the design and manufacture of a bespoke 1 piece carbon fibre wheel for use on the Team Bath Racing 2009 Formula Student car. The major elements of this being the design and FEA analysis of a carbon fibre wheel from first principles. As an extension to this, the design and manufacture of the inner wheel rim from 2008 was dissected and reverse engineered to show a correlation between the FEA analysis and practical testing.
Tim Stokes  Supervisor: Dr Sam Akehurst
Installation of a new ECU and engine mapping
This project covers the work carried out to install a new engine management system for the Universities Formula Student car. Included in this is the wiring of the unit, initial set-up and configuration and then the completion of detailed steady state engine calibration using the team’s dynamometer. The result of this work is a well set-up system with a calibration providing good engine performance throughout the operating range.

Vic Terry  Supervisor: Dr Martin Balchin
Electronic steering wheel for an FS car
The digital steering wheel project looked at bringing Formula One ideas to the TBR 09 car in the form of electronic control. The focus of the project was to create a gear shifter which was not only more reliable than previous solutions but also maximised performance of the car. Other functions were also investigated in the pursuit of achieving better lap times. Now an electronic platform is in place further development in this area can begin.

Luke Tzourou  Supervisor: Dr Geraint Owen
Characterisation and Optimisation Study of Suspension Dampers
Optimising suspension damping can help maximise the handling performance of a vehicle. This project examined the damping characteristics of the much revered Ohlins/Cane Creek Double Barrel shocks for Formula Student. The dampers were dyno tested to produce characteristic force velocity curves for analysis. Dynamic testing of the TBR 08 car and full vehicle modelling in the ADAMS/Car software package was undertaken to attempt to understand the effects of various damping adjustments on vehicle performance.

Aerospace-Automotive Group

Edward Benson  Supervisor: Prof. Ismet Girsul
Control of wing rock
A preliminary study into the effects of flexibility on non-slender wing rock was performed. Three types of rectangular planform were tested; rigid, semi-flexible and flexible. The semi-flexible planforms showed an improvement over the rigid case. This was attributed to increased roll stability due to dihedral. The flexible planforms showed a significant increase over both the rigid and semi-flexible cases. This was attributed to complex aerodynamic effects caused by oscillation at the planforms natural mode.

Peter Bonnington  Supervisor: Dr Chris Brace
Vehicle Duty Cycle Analysis
Driver behavior is difficult to describe objectively & On-Board Diagnostic robustness is dependent upon an understanding of drive style. This research, sponsored by Mahle Powertrain Ltd., contributes several new drive style metrics. In addition, fleet profiles were examined, and trends in OBD performance were analyses. Finally, Neural Networks were used to create models capable of predicting OBD monitor completion based on a minimal number of drive style metrics, highlighting key elements in OBD robustness.

Martin Bounds  Supervisor: Dr Chris Bannister
Lubricating Oil Dilution Issues associated with Biodiesel Use
A concern regarding compatibility of biodiesel with vehicle applications is its oxidative stability, which is inferior to petroleum diesel. Fuel diluted into the crankcase lubricating oil can oxidise and degrade to form polymers, potentially damaging the engine. This project investigated the effect of a range of factors on oxidative stability of fatty acid methyl esters which comprise biodiesel. This was achieved through running a schedule of ‘accelerated oxidation tests’, and analysing the fuel using spectroscopy.

Adèle Bouquerel  Supervisor: Prof. Geoff Hammond
Net energy and greenhouse gas accounting for scaled-up bioenergy fermentation plants.
The objective of this study was to give estimates of the net amount of energy and carbon required to produce one litre of bioethanol from wheat straw, by integrating all inputs throughout the production chain from crop field to the fermentation plant. This evaluation included inventoried all inputs from field to processing plant, and converting them into energy and carbon contents. It was found that producing bio-ethanol from wheat straw could be an energy efficient way to reduce our greenhouse gas emissions.
Edward England  
**Supervisor: Dr Michele Meo**

**Impact on aircraft structures**

Composite materials are becoming increasingly common in aircraft structures. However, impact can cause internal damage weakening the structure. The most common type of internal damage is delamination. This project used ANSYS finite element analysis software to study the affect of delaminations on the vibrational properties of a composite plate. The global natural frequencies and mode shapes were compared for a damaged and undamaged plate. The local natural frequencies of delaminations were also studied.

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Bo Fan  
**Supervisor: Dr Stuart Macgregor**

**Capacity for wind power in innermongolia using mesoscale modelling**

Wind energy is a rapid growing renewable energy. This project studied the wind power capacity in Inner Mongolia, China. A detailed wind speed map was produced, which will facilitate the positioning of wind farms. An area which considered as suitable for wind power developing was calculated. The technically and environmentally exploitable energy potential of Inner Mongolia was estimated. Recommendations were made based on the power capacity as well and the development policy in China.

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Yu Ting Tina Fong  
**Supervisor: Dr Alicia Kim**

**Design Tool for Bi-stable Composites**

For the past 30 years, multistable composites have been actively investigated by engineers and scientists worldwide. The world is intrigued by its ability of having multiple stable configurations without a continuous input of energy. In this project, a numerical model has been studied and developed to predict the curing shapes of asymmetric composite laminates. Experiments have been conducted to validate the predictions.

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Tommaso Rapisardi  
**Supervisor: Dr Jos Darling**

**Modelling of Coal-Fired Power Plant Boilers**

Coal is a major contributor to UK energy production and could soon increase its market share. Volume-restrictions models and a novel Inertance model of fans have been used to simulate the air flow through the Aberthaw coal-fired power plant using MATLAB Simulink. Tests were conducted to investigate the efficiency improvement strategies considered to reduce the environmental effects of coal combustion.
Owen Griffiths  
**Supervisor:** Dr Marcelle McManus  
**Renewable energy option for Bradford on Avon and area**

The town of Bradford on Avon is wishing to reduce their carbon footprint. This project assessed renewable energy resources in the town and surrounding area that could be potential developed to supplement the electricity demand in the area. Recommendations include the development of a wind farm in the area, and hydro schemes to make use of the River Avon. The suitability of various domestic scale micro-generators was also addressed.

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Nelson Tsung-Hsieh Hsieh  
**Supervisor:** Dr Mike Wilson  
**Computational aerodynamics with fluid-structure interaction**

This project involves the assessment of the issues influence the quality of a transient simulation result, student performed the simulation of validation and square cases with the times steps ranging from 0.03s to 0.005s, at the end it was determined that with Re = 204, the vortex shedding frequency was physically accurate, with Re = 408, time resolution is not adequate. Furthermore, significant damping effect of flat plate on Strouhal number was found.

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Tianxiang Hu  
**Supervisor:** Prof. Steve Newman  
**Lift enhancement for oscillating wings**

The objective of this project is to investigate on the lift-generation effect due to the oscillation wing concept. The experiment includes force measurement and flow visualisation for the flat plate with three different planform shapes rectangle, ellipse and delta at Re = 20000. Two different modes of LEV have been observed at St = 0-1.5, in which the variation of the lift enhancement has been significant influenced by natural shedding frequency and the vortex-wing ‘locking mechanism’.

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James Irvine  
**Supervisor:** Dr Marcelle McManus  
**Energy priorities for business users in Bradford on Avon**

Most UK energy is derived from fossil fuels, which has significant effects on the environment. Business accounts for almost half of UK energy consumption, and the 4.7 million micro- and small-sized enterprises are expected to account for a sizable proportion of this. Bradford on Avon is a town with a variety of such businesses, and six were investigated to establish the scope for reductions in energy consumption and the resultant priorities for action.
Improved modelling of heat transfer in penguin feathers

In this paper, it has investigated the problem of heat transfer through penguin feathers. During this investigation, it has outlined the characteristics of heat transfer through porous media. It has been found that the thermal conductivity of the porous media depends on the material property, porosity and internal structure of the two phases, which is valuable for the future design of insulation materials. The good insulation material is lightweight and with a highly porous structure.

Optimal utilisation of the MAHLE downsized engine

Today's automotive developments are emphasised towards reducing fuel consumption. MAHLE downsized engine (MDE) represents the pinnacle of such engine developments. Hybrid electric vehicle (HEV) has shown considerable promise to reduce fuel consumption. This project investigated the best methods to utilise the MDE, accessing the synergy of the MDE in a HEV. Conventional and hybrid powertrains were simulated and the MDE was identified to be best utilised in a conventional vehicle over urban driving conditions.

Turbine cooling experiments

To improve gas-turbine efficiency, the Turbine Entry Temperature (TET) can be increased. However, without using sophisticated cooling methods, increasing TET means that turbine blades operate in conditions far in excess of their material's temperature capability. Thermochromic Liquid Crystals have been used to further understand the fluid dynamics governing leading-edge film cooling; off-surface measurements of film effectiveness were taken from a leading-edge model. These results have also been compared with data from three other experimental techniques.

Modelling of an airship “Aerodynamics and Control”

This project is part of the EarthshipOne Challenge 2009 with the aim of designing a futuristic, solar powered airship capable of travelling 2500 nautical miles. The project mainly covers the aerodynamics and stability and control performance of the FWA-09. As being an unconventional design, the FWA-09 dealt with various challenges during its performance analysis. Computational programs such as Tornado, a Vortex Lattice Method based method was employed to perform further analysis of the airship.
David Marchant  Supervisor: Dr Richard Butler
Damage Tolerance of Composite Stiffeners
Barely Visible Impact Damage (BVID) is of concern to the aerospace industry. In this project, a series of experiments were carried out to ascertain the residual static compressive strength of a composite stiffener subjected to free edge impacts. The results show good agreement with the predictive model used and also highlight the conservative nature of the model. Additionally, an optimisation study was carried out into using non-traditional ply angles to improve threshold strain performance.

Nicholas Marshall  Supervisor: Dr Mike Wilson
Gas turbine CFD
An investigation into the heat transfer within a preswirl system as found in typical jet engine cooling systems has been conducted. A commercial CFD software package has been used to produce results for comparison with pre-existing experimental data at low Reynolds numbers. The relevant flow regimes have been identified and their effect on heat transfer explained. Higher Reynolds number cases more representative of engine cooling systems have also been investigated.

John McHugh  Supervisor: Prof. Ismet Girsul
Pitching membrane wing
The aim of this project was to investigate the response of a flexible wing to a forced pitching motion used to simulate the change in aerodynamic loads due to a gust. A rectangular flexible wing was subject to a controlled pitching motion of varying frequencies and amplitudes. The shape of the wing was then monitored using high speed digital image correlation over the gust period to provide an insight into the wings fluid structure interaction.

Gary Michael  Supervisor: Chris Bannister
The Impact of Biodiesel on Vehicle Performance & Emissions
There has been a growing interest in biodiesel fuel in recent years due to the requirement to reduce global emissions of greenhouse gases, rising crude oil prices, and increasing demand for energy security. However, the effects of using biodiesel fuel on vehicle performance and emissions have not been fully investigated. This project examines the effects of biodiesel on catalyst light-off time, exhaust gas composition, and cylinder pressure using both vehicle and engine trials.

Nick Molesworth  Supervisor: Prof. Andrew Plummer
Bin lift power conversion for refuse collection vehicles (RCV)
A study into the feasibility of conversion of a hydraulic bin lift on a rear-loading RCV to an electric system, whilst also inspecting the inefficiencies in the current hydraulic system. Finding the major source of diminished efficiency, a retrofit solution was offered. Cost-benefit analyses were performed on the retrofit solution and the electric system, calculating the fuel saving for both systems and therefore the reasonable price.

Freddie Nightingale  Supervisor: Dr Zhijin Wang
Acoustic flow control
With many new aircraft configurations becoming feasible through computer control it is vital that the handling and flow characteristics are understood. An important part to consider is the low speed high alpha regime; this is the regime under which wing rock occurs. This experiment mimicked data previously collected and then used acoustic excitation to disrupt the shear layers causing the wing rock oscillations to be damped.

Andrew O’Byrne  Supervisor: Dr Marcelle McManus
Life cycle assessment of home made Bio-diesel kits
Concern about fossil fuels has lead to an increase in the use of homemade biodiesel production kits. This project investigated the environmental impacts of producing biodiesel with a typical example of this system, using Life Cycle Assessment. Results showed this method of production to have a slightly higher impact than larger scale production, but much lower than the production of fossil diesel. Fossil methanol use has the biggest environmental effect, which should be investigated further.

Tim Osmond  Supervisor: Dr Marcelle McManus
Renewable Energy Solutions for Developing Countries
This report assesses the renewable options currently on the market or in development and evaluates their suitability in the context of a rural community in the developing world, using Madagascar as an example. To satisfy the requirements of cooking and electricity, solar concentrators are chosen as the optimum solution and an example is designed and evaluated. A cost versus power output comparison is conducted to assess how this design compares with other renewable energy technologies.
**David Paton**  
Supervisor: Dr Zhijin Wang

**Inlet Vortex**

During low speed operation on the ground, an aircraft engine is susceptible to the formation of an inlet vortex, which can be responsible for the ingestion of debris from taxiway surfaces and can dramatically reduce the lifespan of an engine. This experimental project investigates the feasibility of using a blowing technique to alleviate inlet vortices, using various methods to view and monitor the vortex behaviour and evaluate the possibilities of an alleviation control system.

**Charles Pope**  
Supervisor: Dr Marcelle McManus

**The use of bioenergy heating systems in urban areas**

In order to help minimise climate change a number of different options are being promoted for renewable heat and electricity provision. One option is the use of bioenergy heating in small scale or community projects. The project used lifecycle assessment techniques to investigate the environmental impacts of these heating projects. These impacts were compared with fossil-fuelled alternatives. The use of a biomass boiler running on chipped, waste wood, was found to have the lowest impact.

**Jonathan Poulter**  
Supervisor: Dr Alica Kim

**Can FEA be used to successfully model a vertebra in 2D?**

This project looked at whether it is possible to model an L4 vertebra in 2D using ANSYS. Models of the vertebra were created in the coronal and sagittal plane; they were loaded using results discovered from in vitro testing. The ESO method was used in an attempt to simulate the adaptation of cancellous bone to loading. The results produced matched those found in vivo; graphical evidence confirmed that optimisation was occurring.

**Oliver Pountney**  
Supervisor: Prof. Geoff Hammond

**Turbomachinery Internal Cooling**

The high temperature gas in the mainstream annulus of gas turbine engines can ingress into the cavity between the rotor and stator causing damage to internal components. This study has provided further validation of the Owen (2009) orifice models for two cases of ingress. The limit of incompressible flow has also been quantified and suggests that the theory is useful to engine designers in mitigating the damaging effects of the phenomenon.

**Andrew Pretty**  
Supervisor: Dr Mike Wilson

**Propulsion Optimisation**

The aim of this project was optimising propulsion around fuel efficiency for an aircraft. This was done by exploring proposals by the Greener by Design organisation on how to save fuel on aircraft missions. This meant that engine alternatives, air traffic management solutions and multi-stage long-haul flights were assessed against current standards. Overall it was found that substantial efficiency improvements above 24% were obtainable by implementing the methods which is a positive indication for environmentalists.

**Ed Rafipay**  
Supervisor: Mr Graham Outram

**Solar powered air conditioning**

This project investigates current technology to produce space cooling using solar power. A 50W absorption chiller has been modeled, and a small-scale prototype chiller has been developed using this data. This prototype has been under constant development, and has been designed as a basis to produce a 1kW system for household air-conditioning. The chiller is combined with a solar collector, a hot water tank and a control system, thus providing an autonomous cooling machine.

**Simon Reynolds**  
Supervisor: Dr Andrew Rees

**The Onset of Doubly-Diffusive Convection**

An analysis of the stability of double-diffusive convection occurring above a horizontal surface in a porous medium was carried out. The fluid is initially at a constant temperature and concentration, then the temperature and concentration at the surface are suddenly raised and the stability of the system for varying parameters is examined by a full numerical analysis. This has direct engineering applications including the geosequestration of CO2 underground and the storage of nuclear waste.

**Daniel Ridley**  
Supervisor: Dr Jos Darling

**Experimental Measurement of a Model Car and Trailer**

Investigating the effects of the towing vehicle on caravan snaking using a model car and trailer. Analysis concluded that small gains in stability could be achieved by altering the towing vehicle’s parameters although the greatest benefit was observed by moving the effective hitch point ahead of the car’s rear axle with the use of a simple linkage mechanism. The resulting system remained highly stable at all conditions, while a computer simulation showed that the critical speed for the onset of instability could be doubled with such a mechanism.
Oliver Vistisen  
**Supervisor:** Dr Alicia Kim

**Is Rock’s Recovery Response to Energy an Optimisation Process?**

The development of a discreet 2D Topology Optimisation program was undertaken to investigate theories on the behaviour of the slow dynamics of rocks. Simulated Annealing was used to iterate the structural analysis and find an optimal high stiffness structure. A log cooling schedule regulated the temperature with significant success with no structural control employed. Introduction of such controls were unsuccessful. Various parameters were investigated and calibrated for the successful simulation of a slow dynamics case.

James Stapleton  
**Supervisor:** Dr Michele Meo

**“The Multi-Objective Optimisation of a Composite Formula One Crash Structure using the Explicit Finite Element Software Package LS-DYNA”**

This study focuses on the numerical optimisation of an energy absorbing tubular composite crash specimen being considered for use in a Formula One safety structure. Using the explicit finite element software package LS-DYNA, an investigation into the effects of certain modelling parameters on the behaviour of the structure was carried out. Additionally, an examination into the effects of geometry on the energy absorption properties of an experimentally validated composite crash model was conducted.

Matthew Stott  
**Supervisor:** Mr Andy Green

**A Study of the Effects of Varying Operating Temperature on an Eco-Marathon Engine**

The Team Green Eco-Marathon car engine was struggling to maintain a constant temperature. Consequently the effect of operating temperature on the engines performance was studied. It was found as the engine warmed up the in cylinder pressure during combustion fell. The result of this was a reduction in output torque and power. Critically it was also increasing the fuel consumption. Suggested improvements could reduce fuel consumption by 15% and improve the team’s competition performance." Please note my project title has changed slightly to make it more relevant, it should now read.

Shobia Santhiyago  
**Supervisor:** Dr Gary Lock

**Turbine Blade Cooling-Investigation of film cooling effectiveness using thermocouples and thermochromic liquid crystals**

This project investigated the effectiveness of film cooling at the leading edge of a turbine blade. Results concluded that the coolant effectiveness was strongly influenced by the blowing ratio, hole angle and coolant temperature. Highest effectiveness was obtained at low blowing ratios and inclined holes performed better. The project also identified that thermocouples and CO2 gas concentration technique were ideal for quantitative measurements and thermochromic liquid crystals and infra red thermography for qualitative data analysis.

Elissa Senan  
**Supervisor:** Dr Richard Butler

**Structural design and test of a wing morphing**

The cantilever concept for Wing Morphing for an (UAV) is investigated both theoretically and experimentally by the mean of actuation. Test readings on 400mm long cantilever beam (AL-6082-T6) revealed that maximum deflection of 70mm, 10 degrees deflection angle, is achievable without failure. Hybrid actuation concept is tested, split into two stages; the force required for the second stage found larger than theoretically predicted. Dimension limitations of UAV airfoil and weight penalty are major concerns for future research.

Chris Tams  
**Supervisor:** Dr Andrew Rees

**Front Propagation in Double Diffusive Systems**

This project concerns double diffusive convection in a porous media. It deals with the speed and manner in which a front propagates through a long horizontal porous layer for different convection regimes, including overstability. Applications include geo-sequestration and permafrost. The conclusions and results of the simulations were related to these and implications were considered. Finite difference numerical methods along with FORTRAN were used to model the situation and produced results that indicated that overstable wave fronts were slower than those that were monotonically unstable.

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Adam Rose  
**Supervisor:** Dr Sam Akehurst

**Modelling the performance benefits of a continuously variable supercharger drive system**

A novel forced induction system comprising a CVT-driven supercharger sequentially arranged with a fixed geometry turbocharger was modelled around an existing passenger car diesel engine. The simulated performance was then evaluated against a variable geometry turbocharged version of the same engine, both in steady state and transient conditions. Compared to the baseline, the twincharged engine exhibited substantial torque enhancement throughout the entire engine speed range, and transient response was also significantly improved.

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Ka Hou Wong  
**Supervisor:** Dr Richard Butler

**Optimisation of Post-buckled wing cover panels.**

This project is aimed to optimise a composite post-buckled stiffened wing cover panel which is designed to possess high-load and high-strain capacity, subject to axial compressive load. An optimised panel without post-buckling is also developed in order to investigate any potential weight savings that the post-buckled panel can achieve. The optimisation is primarily conducted by mathematical software MAPLE. In addition, studies in post-buckling behaviour, buckling theory and composite laminate theory of stiffened panel are also heavily reinforced.

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### Machine Systems Group

**Rachel Armstrong**  
**Supervisor:** Prof. Patrick Keogh

**Development of an Active Seal - Determination of Seal Friction**

Sealing in hydraulic cylinders is a compromise between friction and leakage. An active seal could provide an alternative to this compromise by varying the geometry of a seal at different points during a stroke to optimise the seal's performance. To achieve this, a thorough understanding of friction characteristics of seals is required. A method was developed to evaluate the seal friction for two types of seal being considered for an active seal.

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**Michael Bailey**  
**Supervisor:** Prof. Andrew Plummer

**Actuation and control of a morphing wing**

Developing from previous structural projects, an Electro-Hydrostatic Actuation system was designed and constructed. Under proportional closed loop control, a DC motor coupled with a gear pump, connected to a hydraulic actuator was used to actuate various morphing structures. Results from experimental testing were compared against previous results and correlated well, although leakage through the gear pump was identified as a major restricting factor. Further work was suggested including closed loop control of actuating bi-stable materials.

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**Thomas Dee**  
**Supervisor:** Prof. Andrew Plummer

**The modeling and control of a hydraulically actuated robot leg.**

A computer model of a single, biologically inspired robot leg was produced on AMESim software. The model is a hydraulic and mechanical computer simulation of a prototype leg, which has been designed and constructed in Italy. The leg is hydraulically actuated and will eventually form part of a quadruped robot. The model simulates a jumping motion for a variety of input frequencies and body masses and will provide the basis for future leg models.

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Jeremy Easom  
**Supervisor:** Dr Nigel Johnston, Dr Derek Tilley

**Sloshing of Fuel in Tanks**

This project was undertaken to investigate the validity of using CFD to model the mechanics of sloshing in circular cylindrical tanks. A horizontal cylindrical test tank was constructed used to investigate sloshing response to sway motion. A two-dimensional simulation model of the tank was developed in order to compare simulated and experimental results. The results of simulated and experimental testing show reasonable correlation within the limitations of the considerable error produced by the experimental method.

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**Alex Hamlin**  
**Supervisor:** Dr Nigel Johnston, Dr Derek Tilley

**Modeling the gas-oil interface in a landing gear shock absorber**

Within this investigation, a drop-test simulation model was developed, into which a detailed oleo model (provided by Stirling Dynamics Ltd.) was applied. The heat transfer effects inside the shock absorber were studied, and the order of sensitivity of the heat transfer modes was obtained. Modifications were additionally implemented into the oleo model to account for the heat transfer effects in liquid-gas mixtures, with results compared to research findings. Gas dissolution effects were also studied.

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**Jun Rui Haw**  
**Supervisor:** Dr Andrew Hillis

**Modelling of a damaged oil platform**

This was an investigation into the feasibility of a passive damage detection system for offshore platforms based on the monitoring of changes in its vibrational behaviour. The effect of changing deck mass and damage to different structure members was investigated. It was also shown that using a combination of frequency change, amplitude change and an increased presence of higher frequency resonance modes, that damage can be detected.

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Lei He  
**Supervisor:** Dr Nigel Johnston, Dr Derek Tilley

**Modelling and Simulation of a Hydraulic Valve**

This study investigated the flow dynamic of a pressure reducing valve produced by Sun Hydraulics. A dynamic model of the valve was created in Ansys CFX and MATLAB SIMULINK, with the aim of finding the cause difference in performance with the change of exit holes size of the valve. After extensive simulation with the model, the result showed good agreement with past work and experiment data. Conclusion and recommendation was made based on the result.
Matthew Lockham  
Supervisor: Dr Roger Ngwompo

**Modeling and Simulation of Aircraft Landing Gear Using Bond Graph.**
This project looks at the step by step construction of a bond graph model of a simplified layout of the extension and retraction system of an aircrafts landing gear. It then uses this model to create simulations of how the system would perform in adverse conditions such as various component failures demonstrating bond graphs use for design refinement and development as well as failure mode analysis.

Kerim Mathy  
Supervisor: Dr Derek Tilley

**Experimental and Numerical Analysis of Fluid Flow in Porous Media**
The aim of the project is to build a CFX code to model a two phases flow through a porous medium in the context of the vertebroplasty. With using fluid similarities, a modeller and a meshing tool, the system is computed and post processed. The code is finally corrected and optimized using an experiment with the same geometrical, physical and mechanical conditions. The difference between numeric and experiment is at the end less than 21%.

Stuart Mills  
Supervisor: Dr Andrew Hillis

**The Airflow within an Oscillating Water Column Collector and its Effect on Overall System Performance**
This project presents a Computational Fluid Dynamics (CFD) study of the airflow within an oscillating water column (OWC) wave energy converter (WEC). Outwards, inwards and periodic flow simulations were performed in order to determine the losses throughout the system and the flow distribution at the turbine locations. It was found that small modifications to the geometry could lead to an increase in available power.

Charlie Irving  
Supervisor: Dr Pejvani Iravani

**Design and Analysis of a Biologically Inspired Robotic Vision Control System.**
Furtheing existing work in the field, a binocular robotic vision control system incorporating a set of cameras with 5 degrees of freedom and a 1 degree of freedom support was to be designed based on the features and capabilities of the human eye. If successful the result would be the first known system to combine point-to-point and path trajectory controls, with direct stable gaze compensation for all linear and rotational disturbances.

Paul Krysk  
Supervisor: Dr Necip Sahinkaya

**Active Suspension for a Motorcycle**
This project investigated the suspension system of a modern motorcycle. A computer simulation model of the standard motorcycle was created, then road profiles were input and observations made of the behaviour of the system. An active suspension system was represented and modelled in the simulation. The behaviour of the active suspension, when simulated over the same test road profile, was used for comparison and analysis of the system's potential benefits.

Michael Livingstone  
Supervisor: Prof. Andrew Plummer

**Modelling and Control of a Wave Energy Converter Power Take-Off**
The rapidly expanding wave energy industry lacks an independently developed wave energy converter simulation, performance analysis and load calculation tool. Garrad Hassan and Partners Ltd's 'GH WaveFarmer' software is currently being developed to address this market. Creation of a software interface between WaveFarmer's specialist hydrodynamics code and LMS's ImagineLab 'AMESim' hydraulic simulation environment facilitates flexible modelling of complete WEC devices with realistic power take-off designs and a variety of control strategy implementations.

Terence Chung Lam Lo  
Supervisor: Prof. Patrick Keogh

**Dynamic Stress Analysis of Composite Rotor**
Two novel unbalance vibration control techniques for rotating machinery were investigated. The analysis was performed using the finite element method in a MATLAB programming environment. The dynamic characteristic of various rotor elements for a typical rotating system was studied. The control design utilizes the applications of a piezoelectric actuator and bending moments to achieve an active attenuation of vibration excitation due to mass imbalance.

Chris Thomas  
Supervisor: Dr Necip Sahinkaya

**Investigation into the Use of Conventional and Zero-Free-Length Springs within a Steadicam®**
Performance of a typical Steadicam® design which used conventional springs was compared against the same design using zero-free-length springs. The study simulated a cameraman filming the first half of a rugby game which provided a good example of the increased versatility zero-free-length springs allow over conventional springs in gravity balanced applications; the structure is able to remain balanced regardless of its orientation - reducing the energy requirements in this case by a factor of several thousand.
**Active Valves in Aircraft Fuel Systems**

Development of an optimum valve closure profile in an aircraft fuel system to reduce pressure surge and flow overshoot. Involved computer based simulation using Bathfp and experimentation using the Aircraft Systems test rig. Concluded that the Bathfp model simulates the maximum pressure and flow overshoot for full closures well, and the best two-stage closure has a short first stage of 0.5 seconds, a second stage of 1.5 seconds, and a delay between the two stages.

**Micromechanics of PLA-Sisal Composites**

This project was done to assess the mechanical properties of sisal fibres and PLA and the interfacial shear strength of the two materials. Two set of fibres were used, untreated and NaOH treated fibres. NaOH treatment has reduced the tensile strength of the fibre but has increased the IFSS. PLA has proven to be a reasonably strong material in comparison to other thermoplastic matrices. The predicted strength of PLA-sisal composites is 300 MPa.

**Mechanical properties of articular cartilage**

Articular cartilage is a thin white tissue covering the end of joints of our body. In diarthrodial joints cartilage works as very important load-bearing surface. It functions nearly frictionless with excellent wear resistant ability due to its smoothness. Since it's soft and elastic, when subject to load it could reduce the stresses that cartilage and subchondral bone experienced by increasing the area of load distribution.

**Granuair Media**

A spring and link model for the prediction of initial and post-buckling behavior of granular-media is presented. Symmetry is found in some quartic energy terms, appearing to strengthen in secondary buckling the node symmetrically opposite the node with minimum initial buckling load. Critical load folding of the granular chain is observed in secondary buckling about the point of initial minimum buckling load. The model is adapted to de-constrain one end, potentially creating a more realistic granular model.
Gareth Evans  
**Supervisor:** Prof. Tony Miles  
**Wrist guard testing**

This project investigates the potential of a prototype wrist guard device. The wrist guard is intended for use in sports such as snowboarding or skating where wrist injuries are common. Unlike most commercially available wrist guards, the new design focuses solely on attenuating impact force rather than restricting movement of the wrist. This makes it much more comfortable to wear for long periods of time. A variety of padding materials were evaluated for incorporation into the prototype product.

Garcia Lazell  
**Supervisor:** Dr Jimmy Cunningham  
**Development of aerodynamics of recumbent cycle**

Human Powered Vehicles utilise streamlined fairings to achieve astonishing speeds, the world record standing at 82mph. For an attempt at the world record, a concept selection was conducted, examining the aerodynamic cost of various athlete positions. CFD simulation results of CAD designed fairings were experimentally verified in a water tunnel. With pressure drag dominant, results proved a fully recumbent position to be superior, further enhanced by the greater achievable power output in this position.

Dominic Foord  
**Supervisor:** Prof. Giles Hunt  
**Buckling of a delaminated strut in a compression and bending**

Presented is a one-dimensional partially delaminated strut model under compression, formulated in terms of energy, replicating the first two modes of buckling, a symmetric and anti-symmetric form. A linear change in Young’s Modulus from center to surface is implemented to mimic an optimised lay-up composite. A parametric study is undertaken to identify trends in the first and second buckling loads, and the potential for a switch in buckling form with changes in central to surface stiffness.

Fiona Holmes  
**Supervisor:** Prof. Tony Miles  
**Maisonneuve Fracture and Syndesmosis Fixation**

Maisonneuve fractures are sustained when the ankle is forced into external-rotation and pronation during loading, rupturing the joint’s supporting syndesmosis ligaments and causing a high fibula fracture. Present surgical treatment employs syndesmosis screws to re-stabilise the ankle but is limited by its capacity to resist shear forces. This study aimed to develop a testing facility to enable the evaluation of a novel two-hole locking plate fixation device compared against the existing screw fixation.

Jun Jiang  
**Supervisor:** Dr Jeff Vogwell  
**Measuring contact forces between pharmaceutical tablets**

The main purpose of this project was to design and built a tablet launching device for simulating loading and launching processes of the pharmaceutical film coating. It was proposed to analyse the key parameters (loading orientations, materials of rollers, input voltage) affecting tablet output speed. Obtained results showed good correlations between key parameters and table output speed. Tablets loading orientation was found to be the most significant factor related to the tablet spinning motion.

Alex Lazell  
**Supervisor:** Dr Jimmy Cunningham  
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Andy Liszewski  
**Supervisor:** Prof. Tony Miles  
**Knee test rig**

This project produced a knee rig which excludes varus/valgus motion but accurately differentiates the kinematics of the three knees tested. It was found that the multi-radius knee achieves similar tibial rotation throughout extension to the natural knee but the variation of force required exceeds that of the single-radius and natural knee by 30% at 75 °. The single-radius knee produced more similar force variations to that of the natural knee but exhibited little rotation.

Lacy McKernan  
**Supervisor:** Dr William Megill  
**Engineering bra design**

A 3D recognition system was designed to create a 3D model from two 2D models to test the motion of the breasts in a variation of bras. A damped harmonic oscillator can represent the breasts motion. This system is assumed to be linear and the breast and bra are similar to a cantilevered beam from the body. Three constants are needed to be found, the mass of the breast- m, the spring constant- k, and effective damping coefficient-c of the external and internal breast anatomy.

The initial tests and results are based on single straight leg hop; this produces the breasts to freely oscillate due to the feet contact with the floor. This allows the study of the vertical displacement of the breasts.

Fiona Holmes  
**Supervisor:** Prof. Tony Miles  
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Gemma Nicholls  
**Supervisor:** Dr Irene Turner  
**Biomedical Coating Analysis**

The purpose of this study was to compare two bioceramic coatings for joint prostheses integration, at physiological pH, and the more acidic environment found during wound healing. Titanium discs were coated in either hydroxyapatite or brushite, and immersed in distilled water for up to six weeks. Six analysis techniques were used and it was found that the brushite changed considerably over the period, both in appearance and crystal phase composition, whilst the hydroxyapatite remained comparatively constant.
Charles Roman  Supervisors: Dr Jimmy Cunningham, Dr Sabina Gheduzzi  
Analysis of internal forces applied to the bone of an ankle
This study is on the foot and ankle complex and is made up of two different parts. The first part aims at determining the ankle joint force and the muscle loading of the calf group throughout the stance phase of the gait cycle. The method used in this study is based on a commercial software developed by Marlbrook Ltd: the Skeleton and Muscles software. The second part investigates into the most common foot fractures.

Jigar Patel  Supervisor: Dr Michele Meo  
Low velocity impact testing of new generation carbon-fibre composite laminates
This project investigated the low velocity impact testing of a new generation composite laminate. The laminate was treated by introducing micro-perforations in the pre-pregs. The aim was to study the effects of this treatment, and to see whether it was possible to produce a flexible composite. Results were inconclusive as to whether the treatment provided more advantage or disadvantage compared with an untreated composite. The largest influencing factor was the diameter of the micro-perforations.

Jiten Patel  Supervisor: Dr Michele Meo  
Investigation of perforation on the mechanical properties of composites
The main objective of this investigation was to study the mechanical properties of micro perforated composite materials. A model based on test specimen with IM7 material properties was developed and failure conditions and stress conditions were simulated to understand the changes in the mechanical properties. Results showed that the peak stress was proportional to domain length and hole diameter and changes in elastic modulus was negligible and paved a good guidance for future laboratory experiments.

David Penn  Supervisor: Dr Irene Turner  
Designing & Building a fatigue rig for cyclic environmental testing of bioceramics
A fatigue testing rig was developed in order to investigate the long term effects on the mechanical properties of hydroxyapatite/tricalcium phosphate (HA/TCP) bioceramics when used in the human body as a bone substitute. Multiple samples were cyclically loaded simultaneously in compression in water at 37°C to simulate internal human body conditions for walking. It was found that the ultimate compressive strength properties of the samples were significantly reduced after loading compared to their original values.

Laura Simpson  Supervisor: Dr K Bray  
The specific recoil of a football after impact with the cross and the ground
The behavior of a football on impact with the crossbar and its resultant impact with the ground was investigated. A ball launcher was used to fire a football at a crossbar rig and high speed video analysis was used to capture the impacts. Digitisation methods could then be used to find the trajectory, velocities and spins of the ball through each stage of impact which were then compared to

Michael Smith  Supervisor: Dr Martin Ansell,  
Evaluation of Synthetic Hockey Playing Surfaces
One of the International Federation of Hockey's current objectives is the development of a 'water-free' artificial playing surface of international standard; one of the reasons that pitches are watered is to reduce their abrasiveness. This project objectively evaluates six unfilled synthetic turfs by measuring their frictional and abrasive properties under both wet and dry conditions with the aim of identifying what properties and physical aspects contribute to an abrasive or a non-abrasive surface.

Simon Petch  Supervisor: Dr Jimmy Cunningham  
Invictus Wing-Sail Optimization
Invictus is a 20ft C-Class wing-sail catamaran. Having competed in several races the team are looking to improve the performance of their design configuration by making relatively minor changes to the wing-sail. Simple computer based theoretical calculations were carried out to analyse the current configuration and determine if a better setup was possible. A suitable wind tunnel model was then designed that if built could be used to verify these theoretical results.

Ian Barron  Supervisor: Gareth Jones  
Rig for testing ergonomics of petrol nozzles
A requirement for a fuel dispensing nozzle testing rig to characterise their performance and test to British Standards arose from an ergonomic redesign of the Husky fuel nozzle. The characterisation will compare the human inputs (force / travel) to the system outputs (flow rate). The mechanical system required for the testing rig has been constructed which holds, rotates and activates the fuel nozzles. To undertake the testing, fluid control and sensor systems will be required.
**Robert Futcher**  
**Supervisor:** Rod Valentine  
** Automatically Expanding Circular Table**  
A small furniture company, Quadraspire, have a design for an expanding table, which is circular in both its collapsed and expanded form. Their existing design currently requires twenty user operations to transform the table, from its collapsed, to its extended size. The aim of this project was to improve the usability of the table by mechanising all, or part, of the expansion process, with the ultimate target of achieving a fully automated version.

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**Thomas Godwin**  
**Supervisor:** Dr Ben Hicks  
**Snowboard Toboggan**  
This project was to identify, design and prototype a product that fits to any snowboard turning it into a toboggan. The main requirement was to meet user needs, one of which was to make the snowboard toboggan highly manoeuvrable. Investigating the physics behind skiing, and iterative prototyping found a solution to achieve this. The result was a new snow sport to appeal to a more inclusive market.

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**Nick Haskell**  
**Supervisor:** Prof. Glen Mullineux  
**Aesthetic Filling Facility (sponsored by Laleham Healthcare Ltd):**  
Designing a production machine capable filling two different liquids into a single bottle creating a helix type spiral pattern at a significantly lower cost to the limited equipment currently available. The machine is to be used in a UK based manufacturing environment so that a unique product can be provided to the sponsoring company's clients and thus, incorporates modern 'good manufacturing' techniques into its design in order to operate effectively.

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**James Jardella**  
**Supervisor:** Dr Graham Outram  
**Bicycle Cargo-Carrier for the Developing World**  
oogo is a clean safe and affordable rural transport solution for the developing world. Poor transport is a key cause of poverty, and trade often involves loading a bicycle and pushing the goods to market. This sidecar product safely carries up to 74kg, embodies the ability to intuitively lean through corners while cycling and can be produced for as little £31 by metalworkers in Uganda.

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**Matthew Lee**  
**Supervisor:** Prof. Steve Newman  
**Design of a Multi-Process System for a Parallel Kinematic Machine Tool**  
The primary ability to mill, turn, grind and inspect. The final design has the desired single-operation multi-process capability, coupled with fully automated part and operation transfer, powered fixtures, six-sided machining, tool changing and two additional movement axes to convert standard 3 axis PKMs into 5 axis machine tools.

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**Jack Lewis**  
**Supervisor:** Dr Jos Darling  
**A gas saving device for domestic cookers**  
Previous research suggests cooking accounts for a significant amount of gas consumption in the home. Much work has been done to make central heating equipment highly efficient however the same cannot be said for gas cooking. The object of this project was to develop an after market product that to reduce gas consumption when cooking. A prototype was developed which improved the heat transfer efficiency to a saucepan by ten percent.

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**Dominic Povey**  
**Supervisor:** Dr Elies Dekoninck  
**Dynamically-changeable, Space-saving high chair**  
Over 70% of highchair users surveyed said that the highchair they currently use replaces or prevents the use of a chair at the table, 50% said it prevented access to or around the table itself. The speed at which this innovative highchair can be switched between highchair and adult modes is unique within the market and ensures the dining area remains fully functional for both parent and child without the parent having to compromise their furniture layout.

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**Gavin Bishop**  
**Supervisor:** Dr Stuart Macgregor  
**Optimisation of Propeller Propulsion System for a Human Powered Submarine**  
This project studies the methods and theory behind the design of propellers in order to design an optimum propulsion system for the new human powered submarine, Sulis II. This is to be entered in the 2009 International Submarine Races. The effects of the different propeller designs on the submarine were investigated and sensitivity analysis conducted to test the initial assumptions. A speed of around 5.0knts is expected, unfortunately lower than the 8.035knts world record.

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**Robert Futcher**  
**Supervisor:** Rod Valentine  
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Duncan Coulson  Supervisor: Dr. William Megill
Investigating flapping wing motion with application to AUVs
This project entailed designing, building, and conducting experiments with a mechanism that would produce a variably pitched flapping wing motion, like that of a bird, for application to a future autonomous underwater vehicle. What began as an experimental project ended up being more design focused as the complexities of flapping and pitching simultaneously proved difficult to overcome. A well-developed feasible conceptual design remains for future engineers to pick up and take to completion.

Dominic Food  Supervisor: Dr. Pejvani Iravani
Competition Submersibles: Biomimetics AUV control
The effects of propeller guards on the performance of propellers were investigated with a view to both optimising the propulsion of an AUV as well as aiding in developing a reliable control system. The primary investigation was on the effect of varying inlet to outlet areas, but there was some consideration of other factors. It was found, as expected, that a 1:1 inlet to outlet ratio produced optimum thruster performance.

Luke Hollyman  Supervisor: Dr. Necip Sahinkaya
Competition Submersibles: Power transmission
The power output from a person pedaling is compared with the load required to drive an oscillating aerofoil propulsion system. The system is modeled and the effect of changing parameters predicted, from this system parameters are chosen to optimise performance. These are then incorporated into a design for the transmission.

Roanne Perrin  Supervisor: Dr. Michael Carley
Biomimetic propulsion for human powered submarine submarines
This project optimizes the biomimetic propulsion system of the University human powered submarine. The report is a pilot study with preliminary experimental data. It considers 3 main subjects which are the transmission mechanism, the flow mechanism and parameters affecting the flow. The most optimum fins for the Seabomb were found to be made of 4 pieces of plastic and have a dimensionless heave amplitude of 1.2 corresponding to a fin chord length of 0.15m. This may increase the submarine's top forward speed by roughly 40%.

Matthew Pickering  Supervisor: Dr. Mike Wilson
Human Powered Submarine Hull CFD
The Bath University Racing Submarine Team has traditionally used experiments and theory to analyse hydrodynamic effects on vehicles. To improve the range of tools available for design; this investigation discussed the production and hydrodynamic analysis of a CFD model for Bath's proposed 2011 Human Powered Submarine hull, based on the existing RoboPuffin Autonomous Underwater Vehicle. Investigation included: theoretical and experimental validation, design improvements using flow analysis, appendage introduction and comparisons to the existing hull.

Andrew Webster  Supervisor: Dr. William Megill
Competition Submersibles: AUV sonar
The aim of this project is to create a computer program that can extract useable data from sonar images in real time. Specifically this program is designed for use on the University of Bath’s Autonomous Underwater Vehicle (AUV). The program is required to identify salient features of a test pool, as well as track any objects of interest within the water, thus providing the AUV with the capability to map its surrounding environment.

Ian Allerton  Supervisor: Prof. Alan Bramley
Football launcher
This project has worked on designing a system whereby the spin rate and spin axis orientation of a football can be calculated using on-ball instrumentation. The benefits from an instrumentation system where both players and the ball can have various parameters measured would be numerous, and therefore knowing the ball's spin rate would be useful in analysing its flight. Accelerometers are used to measure centripetal accelerations resulting from spinning, and from this the spin rate can be directly inferred.
James Fullana  
**Supervisor: Dr Michele Meo**

**Out of Autoclave Composite Manufacture, The Liquiclave Process**

An ‘out of autoclave’ composite curing technique was developed in the form of the liquiclave. This involved the submersion of resin-impregnated fibres below a fluid which sat a temperature capable of inducing cross-linking within the epoxy resin matrix. The Quality of CFRP fabrications were tested through a range of mechanical, thermo-mechanical and optical techniques and compared to that of autoclaved fabrications. The Exothermic reactions produced during the cure cycle were also analysed.

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Timothy Goode  
**Supervisor: Dr Martin Ansell**

**Rapid Cure CFRP of Aerospace Components**

An investigation into an out-of-autoclave method for the rapid curing of prepreg-based CFRP aerospace components due to the high setup capital, running costs and time required for fabrication using the autoclave. The ‘liquiclave’ is a lab-scale prototype of a new system that has been designed by Airbus UK as a prospective alternative to the autoclave. Mechanical, visual and void analysis was used to compare quality of CFRP panels cured using both methods.

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Simon Harrison  
**Supervisor: Dr Martin Ansell**

**Fatigue of Midsoles in Running Shoes**

The fatigue behaviour of ethylene vinyl acetate (EVA) foams, typically used in midsoles of running shoes, was investigated under realistic running conditions. A servohydraulic Instron testing machine was used to cyclically load different densities of EVA foam to simulate the conditions of long distance running. EVA foam was subjected to the typical stride frequencies and peak pressures experienced during running and hysteresis loops were captured to investigate the change in functional properties of energy absorption capacity and stiffness.

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George Minshall  
**Supervisor: Dr Martin Ansell**

**Cricket Ball Aerodynamics: The Effect of Backspin**

Following a previous university project investigating the effects different variables upon the swing of a cricket ball work was undertaken to modify existing apparatus and allow the effects of backspin to be considered. This involved design and build of a frame upon which the ball could spin and connection of a small motor capable of rotating the ball at required speeds. Upon completion testing was undertaken looking at the effects of backspin upon lateral forces experienced by a cricket ball.

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Joanna Rowe  
**Supervisor: Dr Jeff Vogwell**

**Design and Performance of Knee Sliders for Motorcyclists**

The aim of this project was to gain an understanding of the performance of motorcycle knee sliders and to seek improvement for their design and material selection. Project work was completed in two phases; initial research and market analysis were followed by an experimental program and design development. Results were combined using a quality function deployment approach to create a product specification, allowing an initial design concept to be developed into a successful final design proposal.

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Andrew Readman  
**Supervisor: Mr Andrew Dent**

**The design of function bioceramics**

This project continued recent bone grafting research combining bioceramics and piezoceramics, with the aim of improving bone graft materials and hence further stimulating bone growth. Two approaches were taken, with a modelling investigation to study the interactions between the ceramics and experiments to characterise the samples. However, following initial investigations, substitutions were found to occur in the original calcium phosphate ceramic, so a calcium titanate material was utilised instead to ensure further substitutions were avoided.

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Samanantha Softley  
**Supervisor: Prof. Daryl Almond**

**Investigation into the optimal loading point of a bob skeleton race to gain a competitive advantage**

The University of Bath skeleton push track was modelled in MATLAB to determine the dynamics involved during the start of a race. The modelled predicted that acceleration could be used to determine the optimal loading point. Motion analysis was used to validate the model. Results from motion analysis indicate that this optimal loading point corresponds to the inflection of the acceleration time plot. The athlete should load the sled at this point for optimal performance.

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Christopher Whyton  
**Supervisor: Dr Martin Aansell**

**The Exploration of Table Tennis Bat Technology**

This project was the latest in a series of research projects carried out at the University of Bath in collaboration with Hallmark Table Tennis LTD; a table tennis bat manufacturer. Recently, Hallmark has had to re-assess their product range due to new regulations introduced by the International Table Tennis Federation (ITTF). It was therefore the aim of this project to analyse the performance characteristics of Hallmark’s defensive and offensive bats; comparing them to a market leading product: Tenenergy 05.
2008 Engineering with Language
MEng Year 4 Project Abroad

French

Nathan Chapman  Assessor: Dr Alicia Kim
Supervisor: Jean-Marc Moschetta and Roger Barènes, ISAE (campus SUPAERO), Toulouse, France

Experimental analysis of a Nano Air Vehicle rotor in hover

Small and quiet, Nano Air Vehicles (NAVs) are of interest for numerous surveillance applications as they can easily penetrate a variety of confined spaces. The propulsion system is critical to NAVs, demanding the highest possible thrust: weight ratio. The aim of this project was to optimize a test bench and analyze a number of nano-sized motors and rotors experimentally and analytically. The final result was a comparison between the tested motors and rotors.

Matthew Sujeeun  Assessor: Dr Andrew Rees
Superviseur : R. Dendievel et L. Salvo
Génie et Physiques des matériaux et mécaniques (GPM2), Institut Polytechnique de Grenoble (INPG), France

Outil numérique pour l'optimisation de structures d'accueil de matériaux à changement de phase

Due to their ecological benefits, phase changing materials are becoming increasingly studied in all sectors, from automotive to thermal clothing applications. This project is based around the conception of a reliable code to simulate the effect of a host material coupled with PCM for use as an aid to reduce the consumption of heating energy within buildings. Each separate application is specific to geographical location (environmental conditions) and structural layout meaning that numerical analysis will prove greatly advantageous in finding the most efficient materials and forms.

Nicholas Olesen  Assessor: Dr Chris Bowen
Supervisor: Dr. Michel Perez. INSA, Lyon, France

Interactions Between Dislocations and Carbon Atoms: A Molecular Dynamics Approach

Strain ageing is a phenomenon that occurs in steels as a result of interactions between interstitial carbon impurity atoms and dislocations in the material. Carbon atoms segregate to the dislocation strain field, creating a Cottrell atmosphere and pinning the dislocation in place. Strain ageing has important implications in terms of a steel's mechanical properties, as it can result in a loss of ductility and a significant increase in the brittle-ductile transition temperature. It is of particular concern in high-temperature applications, notably in components used in nuclear power plants. This project uses molecular dynamics software to model the interactions on an atomic scale, with two main aims:
- Validation of a new interatomic potential
- Characterisation of the region around a screw dislocation

Rupert Stock  Assessor: Dr Michael Carley
Supervisor: Dr. Ion Paraschivoiu
École Polytechnique de Montréal (Université de Montréal)

Prédiction de la Performance d’un Pro`l d’Aile (Aerofoil Performance Prediction)

A novel morphing wing system is being developed which allows in-flight adjustment of the profile, to optimise aircraft performance.

Three methods for predicting the aerodynamic characteristics of the possible profiles are tested: turbulence models are compared using a finite volume method (FVM); the FVM is implemented in a manner to simulate the laminar-turbulent transition; and a coupled viscous-inviscid method is tested.

An FVM based solution is presented and future development of the coupled approach is discussed.
Comparison and enhancement of different methods for component mass estimation in preliminary aircraft design

The statistical methods found in literature used for aircraft component mass estimation during preliminary design are mostly based on 1st and 2nd generation passenger aircraft. This makes them unreliable for use when developing new designs. The task was to review and compare available methods using real aircraft data. A selection of the best methods was taken forward and combined to provide a realistic estimate of the operational empty weight of a new design. Methods were extended to account for variations in aircraft configuration. Finally, a software tool was programmed containing the selected methods.

Qualification of copper alloy CuCr3.3Nb2.4 for additive manufacturing by selective laser melting

Selective laser melting (SLM) is a powder based rapid manufacturing method used to build metal parts. Not much research on working copper using SLM has been undertaken. Within the remit of constructing a liner for a rocket engine, the aim of the project was to determine the build conditions required to build 100% dense parts from CuCr3.3Nb2.4 using SLM. By varying parameters such as power, scan speed and hatch spacing, 10mm³ cubes were made using the alloy. Cubes were analysed for density, defects and the presence of pores.

Development of a yaw stability control system for an experimental electric vehicle

Electric vehicles provide new opportunities for influencing their handling characteristics using torque vectoring. This project details the development of a yaw stability control system based on a PID controller, which influences the torque distribution between the four hub motors of the EF1 experimental vehicle. Computer simulations were carried out for various driving manoeuvres to calibrate the controller and then assess the improvements achieved compared to the standard vehicle.

A numerical investigation of the aerodynamic influence of the ground effect on an aerofoil with circulation control

This project is a numerical investigation of the performance of a gapless high-lift design aerofoil which utilises circulation control. Such designs can significantly increase the lift coefficient of a wing, allowing steeper take-off and landing trajectories, potentially allowing noise at ground level to be reduced. Using CFD simulation, the performance of the circulation control aerofoil will be compared with a conventional high-lift model. In particular, this project considers the aerodynamic influence of the ground effect on the aerofoils for a range of ground clearances.
Collette Knill  Assessor: Richard Butler
Supervisor: Dipl.-Ing. Tim Lammering
ILR, RWTH Aachen, Germany

Design Study & Technology Assessment of a Next Generation Single Aisle Aircraft

The aim of this project was to integrate an NLF wing into a single aisle aircraft, targeting a role as the A320/B-737 successor. A design concept was developed and the initial design work carried out to get the basic initial aircraft design. An engine performance deck was built to run a mission analysis of the aircraft. DOCs were then used to assess the viability of this aircraft design.

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Simon Pykett  Assessor: Prof Steve Culley
Supervisor No 1: Dipl.-Ing. U. Kuhls
Hako-Werke GmbH, Bad Oldesloe, Germany
Supervisor No. 2: Prof. Dr.-Ing. J. Blechschmidt
Lübeck University of Applied Sciences, Lübeck, Germany

Investigation and Optimisation of a Dust Removal System for a Compact Road Sweeper provided with an Additional Pre-filter.

Hako-Werke GmbH are currently developing a filter system in order to reduce the levels of hazardous fine dust in the discharged air of a road sweeper. This project investigated the advantages of using an accompanying pre-filter on a custom-built filter test bench. Testing of two types of pre-filters was carried out, along with the optimisation of the filter system by means of pre-filter scavenging and air recirculation.

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Gareth Lewis  Assessor: Dr Nigel Johnston
Supervisor: Prof. Dr P Pfeffer
University of Applied Sciences, Munich, Germany

Analysis of power steering systems in the frequency domain

Much research has focussed on the response of automobile power steering systems in the time domain. However, this project looks at the response of steering systems in the frequency domain, i.e. how inputs of forces and torques into a steering system affect the dynamic response. Hydraulically and electrically assisted steering systems are modelled, taking into account various properties such as friction and damping, and the response to changes in parameters across a range of frequencies are simulated.

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Zehao Yang  Assessor: Dr Andrew Hillis
Supervisor: Prof. Dr. Peter E Pfeffer,
Hochschule München, Germany

Simulation and Modelling of a Hydromount

Engine mounts are one of the most important parts of a car at vibration isolations. Through successful construction of the hydromount model, it is possible in the future to test new engine mounts virtually instead of carrying out tests in laboratories which can cut development costs for auto companies. In this project, a hydromount model has been established and improved. An integrated model which includes an hydromount and the engine weight was later developed aiming at reducing the transmissibility of the mount.
**Prizes 2008**

**Smallpeice Trust Prizes - Design**  
*Group Design Prize: Mechanical/Manufacturing/IED/Automotive*  
*Formula Student Design*

- **Project Manager:** Fabian Pillay  
- **Chassis Team Manager:** Harry Cubbage  
- **Power Team Manager:** Peter Bonnington

**Designers:**

<table>
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<tr>
<th>Andy Boland</th>
<th>Edward Chappell</th>
<th>Jonny Corrin</th>
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<tr>
<td>Peter Elliott</td>
<td>Peter Elliott</td>
<td>Ashley Elliott</td>
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<td>Denis Gorman</td>
<td>Peter Hancock</td>
<td>Paul Krysik</td>
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<td>William Iowe</td>
<td>Kenan Mustafa</td>
<td>Tim Osman</td>
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<td>John Phillips</td>
<td>Adam Rose</td>
<td>Tom Sellen</td>
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<td>Tim Stokes</td>
<td>Matt Stott</td>
<td>Luke Tzourou</td>
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**Group Design Prize: - Aeronautical**  
*Aerospace Team C (AirPaca)*

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<thead>
<tr>
<th>Katie Litherland</th>
<th>Simon Petch</th>
<th>Dominic Food</th>
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<tr>
<td>Simon Reynolds</td>
<td>George Hu</td>
<td>Nelson Hsieh</td>
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<td>Cheng Lee Woon</td>
<td>Dominic Goode</td>
<td>LacyMcKernan</td>
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<td>Jonathan Ford</td>
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**Accenture Business Prize**  
*Business Prize:*  
*Hairfoil Converting Machine*

- **Hugh Qual**  
- **Thomas Dee**  
- **Rhys Jones**  
- **Edward Rafipay**

**Department of Mechanical Engineering Prizes**

- **GE aviation Systems Ltd**  
  *Best student graduating in Mechanical Engineering*  
  Samir Shah

- **Royal Aeronautical Society Prize**  
  *Best student graduating in Aerospace Engineering*  
  Stephen Habgood

- **Ford Motor Company Prize**  
  *Best student graduating in Automotive Engineering*  
  Richard Burke
IET Prize  Best student graduating in Manufacturing Engineering...... Nick Grudgings

CROWN Europe Prize  .................................................. Christopher Bennett
Best student graduating in Innovation & Engineering Design

Frank Wallace Prize  .................................................. Din Yit Tam
Best performance in the Language option of
Engineering with a language course

Joseph Black Prize  ..................................................... Andrew Clark
Best performance in Group Business & Design Project

IMechE Prize  Project Prize (Research Project)...................... Andrew Bryant

IMechE Fredric Barnes Waldron Prize  ......................... Samir Shah
Fredric Barnes Waldron Best Student Prize

HMGCC  Best Specialist Design Project ......................... Timothy Antos
Best student graduating in Innovation & Engineering Design

Thorton Prize  Outstanding academic performance in the final year (SMMG) ......... Heather Driscoll

Armourers & Brasiers  Medal for outstanding project work (SMMG) Alan Ive

QinetiQ  ........................................................................ Andrew Bryant
Best Final Year Project displaying Integrated
Mechanical/Electrical Engineering

Persides Formula Student Project Prize  ....................... Daniel Curtis
Top Formula Student Final Year Research Project

Frazer-Nash Consultancy Ltd  ....................................... Stephen Habgood
Aerospace Project Prize  ............................................. Robert Tipplesbest
Best Student Research Project in Aerospace

Rencol  Best 1st Year Student ........................................ Valentina Bosco

Schlumberger  ............................................................ Ben Lane
John Barr Memorial Scholarship for Best 2nd Year student

ITCM  Excellent 2nd Year Performance in Design .............. Bhavin Mistry

Rolls-Royce  Highest level of academic ability in Year 3 ....... Herve Hilaire

Bugatti  Best Formula Student Input from 3rd Year student . Fabian Pillay

William Siemens Medal  ................................................ Simon Pykett
Best Industrial Placement Performance combined
with Other Achievements
The Department of Mechanical Engineering would like to thank the Alumni for sponsoring this 2009 Design and Project Exhibition booklet.

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It is hoped that all students will keep in touch and participate with the University over their subsequent careers.