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Welcome to the 2008 Design and Project Exhibition and the Joseph Black Lecture given by Dipl.-Ing. Frank Ludwig of the world famous BMW Group.

This booklet contains details of the 20 Group Design and Business projects, including 5 Aerospace projects undertaken by 3rd year students and the 158 engineering projects taken by 4th students. We have again included in the booklet a brief synopsis of each of these engineering projects so that people will have a more complete understanding of the activities being undertaken. Details of all projects are included on the Departments website at http://www.bath.ac.uk/mech-eng/design-exhibition.

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.

It is interesting to reflect on Fielden's definition of Engineering design:

"Engineering Design is the use of Scientific Principles, Technical Information, and Imagination in the definition of a product, machine or system to perform prescribed functions with the maximum economy and efficiency. (Fielden Report Engineering Design 1966)

It is clear that it includes what were thought of as the key ingredients at the time, namely; science, information and creativity combined with the drivers of costs and the underlying thrust of engineering to strive to improve efficiencies. However what it does NOT include are the topics that are the focus of today's lecture, namely people and manufacturing. It is now clear that what you have to do is to design great products that delight and engage people and to design great manufacturing systems and associated great "people systems". This is required to ensure that product quality, manufacturing efficiency, continuous improvement can all be engineered into the overall system by this winning combination of products, people and manufacturing.

It is thus particularly appropriate that we have Frank Ludwig of the BMW Group to deliver the 2008 Joseph Black Lecture Design and Manufacture: Dealing with technical and cultural aspects.

2008 Joseph Black Lecture
Design and Manufacture: Dealing with technical and cultural aspects

Dipl.-Ing. Frank Ludwig, MSc
BMW Group
Painted Body
General Manager Quality Management and Technology Steering Body-in-White
80788 München
Germany

Prof. Steve Culley
On behalf of the design team.
Engineers have shown their ability to produce a whole range of excellent products across different sectors ranging from aerospace, complex, consumer durables, civil and petrochemical structures to those in the topic of this lecture:- the automotive sector. However further to the issues associated with the product: What are the additional challenges of international business and technology.

Clearly engineers are extremely competent and well versed in solving sophisticated technical and analytical problems but is this what it is all about? Isn’t there another factor that is much more complex than the most complex machine: People? and their role in the overall operational processes. Or do we just leave this ‘factor’ to the Managers? After all that is the focus of their main activities.

Clearly, this is not an option. What might seem to us Engineers as a ‘soft’ issue, an issue that is not really tangible quickly becomes the make-or-break in many ventures, especially when they involve people from different cultures and backgrounds.

The purpose of this lecture is to investigate the importance of being excellent at both Engineering and Intercultural Management to bring success to ventures in Design and Manufacture.

First, the level of international co-operations of UK- with German companies will be discussed. Germany is the UK’s second biggest trading partner with German companies employing 420,000 people in the UK. For BMW Group, the UK is the most important foreign country for manufacturing: There are four major BMW Group factories in the UK. Apart from the Rolls Royce factory in Goodwood, the MINI Production Triangle represents the most significant operation with three sites (Swindon, Hams Hall and Oxford). At the start of New MINI, especially the ex-Rover factory in Oxford faced significant challenges that were overcome by introducing NOW the New Oxford Way.

In the second part of the lecture, an overview of the aspects of intercultural management is given, using the MUSIC© model. The model describes five important elements that make up this all-important factor of dealing with people: relationships, uncertainty tolerance, sense of time, personal behaviour and of course communication.

The planning of Plant Leipzig.
The layout of the plant: flexible and communicative.

Only when you have mastered the cultural challenges within a team, can you start to tackle the technical issues. The third part of the lecture describes one of the most complex technical challenges in modern vehicle production, the associated design and construction of a new plant to produce a new automobile. Based on the experience of the existing factories as well as lean production principles, in 2005 BMW Group opened the Leipzig plant in Germany. Apart from winning several Architectural awards, the plant represents a benchmark in factory process design.

Cultural Aspects of Engineering Management.
Overview: MUSIC intercultural Model.
These approaches will have to be suitable to deal with the significant changes that will impact on the automotive sector in the near future. Thus the end of the lecture is marked by a brief look ahead: The most significant challenge that might even threaten the car industry are the issues associated with: Sustainability. Thus part of the Group strategy "Number ONE" will be outlined to illustrate the way ahead.

BMW is convinced that this strategy will lead to success. However, to succeed, excellence in Engineering Skills in design and manufacture and in Intercultural Management will be paramount.

<table>
<thead>
<tr>
<th>Key indicators</th>
<th>2002</th>
<th>2007</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy consumption (MWh/car)</td>
<td>2.62</td>
<td>1.95</td>
<td>-25%</td>
</tr>
<tr>
<td>CO2 emissions (ton/car)</td>
<td>0.72</td>
<td>0.51</td>
<td>-29%</td>
</tr>
<tr>
<td>Water consumption (m³/car)</td>
<td>2.91</td>
<td>1.88</td>
<td>-35%</td>
</tr>
<tr>
<td>Waste recycled (percentage of total waste)</td>
<td>30%</td>
<td>70%</td>
<td>+134%</td>
</tr>
</tbody>
</table>

Future target: 5% improvement of key indicators per year


MEng Group Business and Design Projects
**Design Brief**

To design a human-powered submarine to compete in the International Submarine Races (ISR) held at the David Taylor Model Basin in Maryland, USA. The ISR consist of straight-line ‘drag’ style races with submarines competing to record greatest speed over a 10m section of the 100m race track. The team will enter the 10th ISR races in June 2009 and aim to improve on the university’s 2007 2nd place race performance of 2.092 knots.

**Specification/Key Issues**

- The submarine must be capable of speeds approaching 6 knots if it is to beat the 2007 1st place entry Omer 6 from the University of Québec.
- The ISR judging and directors’ committee define a submarine in the context of the races as “a free flooding (liquid-filled) vehicle that fully encapsulates the occupant(s), and operates entirely beneath the surface of the water”. The pilot breathes using a scuba tank attached to the inside of the submarine.
- The team will enter the single person, non-propeller category of the races.
- The propulsion system must be directly coupled to the pilot and may not incorporate any stored power devices.
- All ISR entries are required to incorporate a pilot rescue and emergency exit hatch as well as an emergency buoy which will float to the surface if the pilot releases a dead-man type switch.
- Submarine construction and competition entry will be funded entirely through sponsorship and the design should reflect the associated budget limitations.
- Construction work will take place within the Department of Mechanical Engineering. The submarine will need to be shipped to the competition in a state where it can be easily assembled for the races.

**Achievements/Description of the Design**

The 2009 submarine design concept incorporates a symmetric propulsion system with a pair of oscillating foils positioned towards the stern. The pilot operates in a prone position towards the bow to give a clear view of the race track markings on the basin floor. A low friction crank shaft type transmission system mounted on an aluminium chassis converts the pilot’s pedalling input to the oscillatory propulsive motion. Stability and control are achieved through sets of split static stabiliser / mobile rudder or dive plane surfaces at the stern, whilst low speed depth control close to the extremities of the basin is achieved through an additional set of forward dive planes. The control surfaces are manually operated by the pilot, through a bicycle cable linked system. The submarine hull and access hatches are built from fibre-glass and the design incorporates buoyancy elements that can be used to trim the submarine.

**Designers:**

M J Livingstone  
L Hollyman  
D Coulson  
R Futerch  
C Groves  
I McCoach

**Supervisor:**

Dr. William M Megill

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**Design Brief**

Work in the field of rehabilitation robotics has been going on for 20 years, but no really innovative solutions have been found. Typical designs are the kind of thing you see being used in assembly lines. Some have attempted to mount robotic arms on wheeled and powered bases. It would seem some more adventurous design approaches would be worth exploring.

The room could become the robot, or maybe the device could crawl over the wall and dock into positions such as kitchen work surfaces. Control is a key issue. How can we tap into the remaining abilities of the user to control a multi-degree of freedom (DOF) manipulator without causing frustration?

**Specification/Key Issues**

- The product must able to help the user perform Activities of Daily Living (ADLs).
- It should be capable of picking items up and moving them around the home environment.
- Be aesthetically acceptable to the user. It must convert limited user motion into a multi-degree of freedom response.

**Achievements/Description of the Design**

REBO# is a rehabilitation robot mounted on a ceiling rail and track network. The mobile robot unit provides a severely disabled user with greater freedom, by controlling a 6-DOF manipulator arm and “trident” gripper mechanism. The device replicates the biomechanics of the human arm and hand, and through stereoscopic video imaging is capable of performing a range of ADLs and household “fetch and carry” operations.

**Product Benefits include:**

- $ Adaptability to accommodate a wide range of user capabilities.
- $ Operation in unused ceiling-space providing minimal obstruction.
- $ Minimal framework built around user to reduce intimidation and better aesthetics.
- $ Reduction of user dependence on carers.
- $ Empowerment of the user to regain control of their immediate environment.

**Designers:**

G. Bishop, F. Holmes, J. Jardella, A. Liszewski, G. Michael

**Supervisors:**

Prof A Miles  
Prof R Orpwood.

**Sponsors:**

Bath Institute of Medical Engineering (BIME)
Solar Powered Boat

The Frisian Solar Challenge is a solar powered endurance boat race through the Frisian waterways of Holland. The team set out to design a highly competitive boat ready for manufacture to enter the competition in 2010. The proposed solution must adhere to regulations set for category A of the competition, where the boat is single-manned, and solar panels are supplied as standard by the race sponsors. The boat must cover 220km in 6 consecutive days.

**Design Brief**

The Solar Boat:
- Will be powered only by solar energy
- Will travel at an average speed of 6 knots
- Is 5.8m long and 2.4m wide
- Has sufficient manoeuvrability for the competition
- Is comfortable and practical for use
- Is structurally sufficient for its application

One key issue is to secure sufficient sponsorship so the team can afford to take part in the competition. Another is to develop a risk assessment for both the transportation to, and participation in the event for all team members. Safety regulations will also need to be strictly abided by.

**Specification/Key Issues**

**Achievements/Description of the Design**

A Trimaran was chosen for stability; ease of mounting the solar panels; and for effective hydrodynamic purposes. Aiming for a highly innovative design, the Hull is to be made from a natural composite consisting of Hemp fibre, and resin sourced from CNSL, Cashew Nut Shell Liquid.

**Designers:**
- Thomas Godwin (PM),
- Victoria Thompson,
- Matthew Pickering,
- Andrew Webster,
- Peter Glacken

**Supervisors:**
- Dr William Megill,
- Dr. Necip Sahinkaya

**Sponsors:**
The University of Bath, Waverider

Design Brief

There is increasing pressure in the UK to focus on sustainable energy as a way of reducing carbon emissions and national dependency on crude oil. The Renewable Fuel Transport Obligation has introduced 5% biodiesel to UK pump petroleum blends as of April 2008. There is intent to increase this percentage to around 10% by 2020 to fulfill EU targets, which signifies that there is a clear market for biodiesel in the UK at present and in the future. However, the competition for land between crop biodiesel and agriculture has been partly a cause of the rising costs and shortages of food. Ecoligae is aiming to provide a solution to the food versus biodiesel problem by producing biodiesel from algae that uses order of magnitudes less land. We will extract the oils from lipid rich algae to form biodiesel.

**Specification/Key Issues**

As a group, ecoligae are designing a production facility with the following key design areas:
- Growth and harvest of algae.
- Process of algae to produce 1.3 Million Gallons of biodiesel per annum.
- Process of the remaining mass to form fertiliser pellets and nanofibres.
- Minimise waste through closed loop design and use of natural resources
- Modularity for future expansion.

**Achievements/Description of the Design**

The business model for ecoligae was based upon a self contained production facility with the following design features:
- Closed growth tanks that maximise exposure to sunlight and allow supply of nutrients, heat and CO2.
- A centrifugal harvester that separates 95% of the growth water from the algae.
- Screw presses that extract 1.3 Million Gallons of biodiesel per year.
- An extruder, pelleting and packager that outputs 4100 tonnes of algal fertiliser per year. An industrial scale process for extraction of nanofibres is yet not possible; therefore it will be kept in the Research & Development phase.

The group decided to focus on designing a machine that combines the oil extraction, extrusion and pelleting processes as other elements are commercially available. The facility would have 10 of these machines capable of:
- Providing a controlled feed of algae to the extruding screw.
- Extracting 130, 000 Gallons of Biodiesel per annum.
- Extruding and pelleting 410 tonnes per annum of remaining mass for fertiliser.
- Packaging the total 4100 tonnes per annum of fertiliser in 15kg bags for final sale.

**Designers:**
- A.Ahmad, F.Alias,
P.Kermack, A.O. Byrne,
O.Pountney D.Ridley,
Professor J.V incent,
Mr. M.Hinds

**Supervisors:**
- Professor J.V incent,
- Mr. M.Hinds
**Heat Recovery in a Restaurant**

**Design Brief**

The overall aim of the project is to utilise waste heat from the restaurant and appliances contained inside more specifically, cookers. It is thought that the result of which will be to reduce utility costs (noting the current situation of rising energy costs) and also to increase the marketability of the establishment to customers.

**Specification/Key Issues**

The product will reduce energy usage within the restaurant by pre-heating water for the boiler. The energy used to heat the water will be recovered from the heat emanating from the cooker surfaces and furthermore, from the convection through the extractor duct.

**Achievements/Description of the Design**

The design consists of several major elements:

- A storage tank to be used as a buffer for hot water.
- A pump to circulate water around the system.
- Two heat exchangers one above the cooker, and one inside the extractor.
- Removal and maintenance provisions for all aspects of the design.

**Designers:** Chris Tams, Sug Patel, Charlie Irving, Thom Grey, Jack Lewis

**Supervisors:** Dr Jos Darling, Dr Derek Tilley

**Sponsors:** Riverstation Restaurant, Bristol

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**ULTra Vehicle Testing Rolling Road**

**Design Brief**

The project is to design a rolling road to test Urban Light Transport (ULTra) vehicles that are a form of low power, electrically driven personal rapid transit (PRT) and have been developed by Advanced Transport Systems Limited. The facility is intended to be used so that vehicles can be tested without having to drive on the network, where any stoppage or breakdown would cause significant disruptions. It is expected that the facility will be used to check that vehicles are performing correctly before releasing them back into service after maintenance and also that it may be useful for fault finding diagnosis where the ability to drive the vehicle whilst observing or measuring the dynamics may aid ATS in providing a reliable service. Some degree of automation of the testing will be required.

**Specification/Key Issues**

The Dyno-Electra 9000 was to meet the needs of ATS, Arkk and BAA by providing testing to:

- **Ensure the vehicle performs to specification**
- **Ensure customers experience high quality PRT journeys**
- **Guarantee a high reliability PRT service**
- **Certify the safety features of the vehicles**

**Achievements/Description of the Design**

The Dyno-Electra 9000 offers a 25 minute throughput time for a comprehensive vehicle power, performance and sensor test, servicing a network of 400 vehicles once each month. It only requires an area of 4m by 3.5m, which is extremely beneficial for our customers where often space is a concern. The facility has been designed to simulate the mass of the ULTra vehicle and so when the vehicle is accelerated on the rollers.

To ensure that the wheels are both pointing directly forward and are aligned, the Dyno-Electra 9000 also has a unique wheel alignment device, which measures the position of the wheels in relation to the vehicle, the ground and each other. This ensures the vehicle always points in the direction desired and input from the control system.

The vehicle is secured during the testing procedure to guarantee that it stays on the rollers, but as an extra safety measure, the facility also has an auto shut off mechanism should the vehicle stray outside a safe working area or if a power failure occurs.

**Designers:** Sophie Edwards, Lei He, Nick Haskell, Dimitrios Kaskarelis, Georgina Mann

**Supervisors:** Dr N Johnston, Prof. A Plummer

**Sponsors:** Advanced Transport Systems Ltd
**Mini Assembly Robot**

**Design Brief**

ABB is a global leader in power and automation technologies, but to maintain their market lead they are looking to produce robots an order of magnitude smaller than those which are currently available. The project brief was to design a small robot suitable for assembly operations with an electrically powered serial six degree-of-freedom arm. This was expanded to the design of a complete assembly solution, embracing the concept of concurrent design, with the robot system capable of assembling small, high price, high volume products such as cameras and multimedia players.

**Specification/Key Issues**

- As a test-case, the final design should have sufficient payload, reach, force-exertion and precision to assemble a Lego model.
- The robot should be capable of performing this task with at least the same speed as the human worker (under 10 minutes).
- To be cost-competitive, the retail price of the robot arm plus controller should be equivalent to around one year’s salary for an assembly worker in the developed world, with the total assembly system remaining cheaper over the three year life.

**Achievements/Description of the Design**

The product exceeds the brief set by ABB in that the total assembly solution comprises not just the robot arm, but also the end-effector, jig system, feed mechanism and safety system. These ‘extras’ enable the arm to assemble anything from cameras to toys and pharmaceutical devices with maximum efficiency and minimum cost. The reduced cost of assembly using our robot will diminish the need for outsourcing production to the Far East and so bring production back to Europe, which will in turn reduce the environmental impact of global trade.

**Designers:** G. Nicholls, A. Park, A. Rouse, J. Walters, S. Dahdah, K. Lim

**Supervisors:** Mr Graham Outram, Dr Roger Ngwompo

**Sponsors:** ABB

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**Highly Automated Logistics System**

**Design Brief**

In 2007, 15% of all retail spending was done online, more than doubling sales figures for 2006. Customers prefer the discount prices that can be found online but are also demanding convenient and quick delivery. To be able to satisfy this demand whilst still remaining profitable, retailers require highly efficient distribution centres. Improved performance with regards to order volume and mix capability, decreased response time as well as reducing the number of operators is highly desirable for such companies. A highly automated system that can store, select and deliver goods ready to be packaged has been designed in collaboration with hardware supplier Screwfix.

**Specification and Key Issues**

The main system requirements are:
- To fit the system within the existing warehouse area of 290,000ft² (nearly 4 football pitches).
- Increase both SKU count and storage volume by at least 30%.
- Ensure the system is economically viable, with a key objective being to reduce the number of operators.
- Design a modular system that can be readily adapted to satisfy alternative warehouse requirements.
- To at least halve the current system response time.

**Achievements / Description of the Design**

The fully integrated design solution compromises separate sub systems which function together to meet the requirements. The main achievements are:

- A 45% increase in the number of orders which can be processed per day.
- A response time which is reduced to less than 5 minutes, allowing later on-line ‘last orders’ to be taken.
- Significantly fewer manual operations are required, and therefore fewer operators.
- The system is highly space efficient and offers improved stocking density.
- Picking errors will be reduced due to improved control.
- The target selling price remains competitive compared to other suppliers whilst offering greater performance.

**Designers:** Ben Cohen, Jem Easom, Bo Fan, Matthew Lockham, Leo Mattioli, Stuart Mills.

**Supervisors:** Dr Richard McIntosh, Mr Bob Jardine

**Collaborations:** Screwfix.
**Design Brief**

Smurfit Kappa Machines Systems in Yate are currently investigating how to integrate robots into their existing packaging lines. Packaging designs are now fast changing and existing systems do not offer the flexibility required to cope with this. Robots can easily be adapted for different tasks by changing the tools (end-effectors), thus their integration into existing systems could have the potential to reduce new equipment costs and future-proof machinery.

**Specification/Key Issues**

- To enable automated operation change within 1 sec.
- Complete repeatability of processes.
- High reliability of system.
- Ensuring cost benefits of new system over constant adaptation of existing systems.

**Achievements/Description of the Design**

The solutions have been designed with maximum adaptability, with the capability of being used across the food and beverage packaging industry. The solutions designed covered the following areas:

- A quick release automated tool change adapter for robot end-effectors enabled end-effectors to be changed quickly with no human intervention.
- A storage system for alternative end-effectors minimised work cell space required whilst maximising the accessibility of tools to robot.
- The configuration of single-purpose end-effectors was optimised for handling cardboard blanks, a 5-gallon drum and multiple cereal boxes.
- A multipurpose end-effector allowed 3 tasks to be performed with no tool change.
- An adaptable end-effector enabled different tasks to be carried out, without the need for detachable air and other services to the tool.

**Designers:** Christopher Dexter, Ning Li, Gareth Evans, James Irvine, David Penn, Stephanie Watkins

**Supervisors:** Dr. Glen Mullineux, Mr. J. Matthews

**Sponsors:** Smurfit Kappa UK

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**Design Brief**

A research team at the University is investigating the design and manufacture of bespoke, orthopaedic insoles. These are machined from medical grade polypropylene using a three-axis CNC machining centre. The process currently produces a very high volume of waste as only 4% of the raw material is used - the remaining 96% is discarded. The main aim of this project is to identify a system for collecting, processing and reforming this waste into new feedstock.

The client's long-term strategy is to create a sustainable, closed loop manufacturing and recycling system that will also include the recycling of the insoles at end of life. This process will vastly reduce the cost of the operation because considerably less raw material will have to be purchased. It will also reduce the environmental impact of the process as less material will be sent to landfill.

The manufacturing enterprise is still at the development stage, however, they hope to increase production ten-fold in the next two years to 50 pairs per day. This is potentially combined with a move from the University workshop to a dedicated manufacturing facility. There is also potential for the business to expand into other sectors, such as the recycling of prosthetics and other medical polymers. The US market also holds great potential as over 4 million pairs are produced annually.

**Designers:** Philip Parkes, Nick Molesworth, Alexis Kadis, Matthew Lee, Dylan Mitchell

**Supervisors:** Prof. Stephen Newman, Mr Vimal Dhokia

**Sponsors:** University of Bath
Design Brief:

Rencol are the world leaders in the production of the extremely versatile spring fasteners better known as tolerance rings. The unique properties of their product attract customers worldwide from the automotive, domestic appliances and hard disk drive industries.

Despite large growth in turnover over the previous few years Rencol have found that they are missing out on a huge potential market of customers. At the moment the rings are dispatched in big plastic bags where the rings are liable to tangling and distortion which needs to be sorted manually at the customer end. Also the current counting method involves weighing the rings and, due to the nature of the material used, leaves a number of rings in the bag with a plus or minus five percent error which is unacceptable to some customers. If a new way could be devised to handle and package the tolerance rings it would open up a whole new market for Rencol tolerance rings.

Specification and key issues:

The main requirements of the new handling system for Rencol are:

- To provide the customer with completely detangled rings
- To provide the customer with an exact number of rings as per their order
- To help the customer with automation into their process by packaging or sorting the rings so they are easier to handle

Achievements/description of the Design:

It was decided that in order to do a complete analysis of the solutions two different designs would be taken to a detailed design stage:

1. The first design involved an alternative packaging system where the tolerance rings are automatically packaged on cardboard tubes as they come off the production line at Rencol. They would then be stored and shipped to customers in this manner at a premium price. This rings would arrive detangled and counted and ready to be automated into the customer's production line.

2. Alternatively a detangling machine was designed that could be marketed to the customer directly. By loading the tolerance rings into the detangler the customer would be provided with a steady stream of detangled rings that could then lead into their automation process.

Designers:  N Beltaji,  S J Bailey,  J Cherrill,  J Haw,  I Peters

Supervisors:  Prof. PS Keogh,  Dr AJ Hillis

Sponsors:  Rencol Tolerance Rings Ltd

Flexible Automation Demonstrator

Design Brief

The task set was to design an automated assembly rig, on which metrology and robot units could be deployed to create a demonstrator assembly cell capable of assembling high accuracy, large scale components. It would also need to enable robots to carry out a number of secondary manufacturing processes (such as fettling, drilling), and be flexible enough to accommodate a wide range of different components.

The cell was to be sold to University Engineering departments. It would be used to carry out research into improving automated assembly techniques, such as better integrating metrology and robotics. This would then lead to sponsored research projects with large scale assemblers, such as in the aerospace industry.

Specification/Key Issues

The key aims of this project were to create a product that was affordable, flexible and modular.

In order to purchase this kind of product, a university would seek Government research funding (via the EPSRC). An affordable product would make research funding easier to obtain for Universities, while a flexible product could justify the Government funding a number of these purchases across different Universities in the UK. Flexibility comes at a price, and the key to the project was balancing affordability and flexibility.

Achievements/Description of the Design

The final design consisted of:

- A steel frame, using box joints to enable the members to be lengthened to accommodate different components
- 4 Hexapods, designed in house, to enable the components to be easily manipulated
- 2 Robot tracks either side of the frame, from which robots could be deployed and moved from one end of the frame to the other
- An overhead actuator from which a Photogrammetry unit could be deployed

Designers:  Daniel Stirk,  Matthew Dodds,  Peichao Li,  Katie Holt,  Martin Bounds

Supervisors:  Prof. Paul G Maropoulos  Dr Jafar Jamshidi

Sponsors:  Airbus Filton
Design Brief

Specification/Key Issues

Hairfoil (as pictured) is a foil made from a specific aluminium alloy which is used by hairdressers to dye hair and protect individual strands from the rest of the cut. This design project is sponsored by Procure who are the leading converter of Hairfoil in the UK. They have asked YouBAC to design a fully automated machine to convert, non-stop, master rolls of Hairfoil into smaller, dispensable proportions for salons. The new machine will then allow Procure to allocate staff time more effectively and help them to compete with the emerging, converting markets in the East where the labour is cheap.

Achievements/Description of the Design

The Hairfoil Converter One (HCO) achieves the above key issues through the incorporation of a novel four mandrel hub system. Three hubs are aligned within the HCO in such a way that the slit aluminium web does not twist or tear. The hubs allow the converting processes to be broken up into smaller parallel tasks and obtain a 25 second cycle time. The four mandrel hubs and slitters are both automatically adjustable, thereby substantially reducing set-up time when changing between different sized master rolls. The HCO can convert one master roll into 720 rolls of Hairfoil in two hours without any operator interaction.

Designers: Thomas Dee, Rhys Jones, Hugh Quail, Edward Rafipay
Supervisors: Prof. Steve Culley, Mr Rod Valentine
Sponsors: Procure

Design Brief

Specification/Key Issues

Poor racetrack conditions in horseracing have a direct impact on the incidence of injuries to the horses that compete. In an Industry that has a £3Bn annual impact on the UK economy, the implications of these injuries account for an estimated £100m in losses. Touted as the safer option, the synthetic 'All Weather Track' (AWT) is still a developing solution and has proven unsatisfactory.

Current surface characterisation methods are typically qualitative and subjective, using terms like soft, deep, cuppy, hard and fast. A need for accurate quantitative measurement tool exists in order to aid development of AWTs and improve the way in which racetracks are monitored, leading to more efficient and standardised maintenance protocols.

Achievements/Description of the Design

The main requirements of the surface measuring instrument are:

- Quantitatively measure biomechanical response of AWT surfaces
- Be portable for use in lab and in situ
- Take measurements that are relevant to the biomechanical response of a racehorse in gallop
- Be robust enough to withstand debris and poor weather conditions

Designers: J Bhatti, S Domone, P Griffin, N Hutton, M Smith
Supervisors: Dr I G Turner, Dr J L Cunningham
Sponsors: University of Bath
Design Brief
The project concept is to design a single-seater racing car and then submit the design for 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 its 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" http://www.formula student.com/aboutus/

Specification/Key Issues
Team Bath Racing 2009 has come to the conclusion that in order to do well 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 (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 the design has been kept strictly to 250Kg, including driver weight.

Designing bespoke parts and working within the regulations set out by the SAE there are be few, if any Chainless drive, supercharging and running E85 in the following fuel. Many of these design specifications are also very innovative, with no previous Bath Formula Student team having presented a modular chassis design using a chainless drive system or full carbon fibre wheels.

Achievements/Description of the Design
The final car specification as release for the class 3 competition 2008 will include:
- Bespoke Supercharged V-Twin engine running on E85 fuel
- Bespoke Sequential Shift Transaxle
- Half Length Steel Spaceframe with Carbon Skinning
- Bespoke Full Carbon Composite Wheels

Project Manager: Fabian Pillay
Chassis Team Manager: Harry Cubbage
Powertrain Team manager: Peter Bonnington

Designers:
- Andy Boland,
- Jonny Corrin
- Ashley Ellison
- Peter Hancock
- William Lowe
- Tim Osmond
- Adam Rose
- Tim Stokes
- Luke Tzourou

Supervisors:
- Kevin Robinson,
- Geraint Owen

Sponsors:
- Royal Navy Castrol,
- Perkins Engines Co Ltd Deloitte,
- Viking Recruitment, Accenture,
- CP Engineering, Ricardo,
- The Bugatti Trust,
-

Dedicated High Capacity Freight Aircraft
Team A

Design Brief
Commercial freighter aircraft have traditionally been developed as derivatives of existing passenger aircraft. A dedicated freighter design could offer the potential for a step-change in freighter operating costs. The aim of this project is to design a dedicated high-capacity freighter to meet the needs of the General Market Freight operators (e.g. Cargolux, Singapore Airlines Cargo) on major routes (e.g. Shanghai to London Heathrow), for an entry into service date of 2020.

Specification
- Payload ......150 - 200 tonnes at 12 lb/f3
- Design Range (still-air).........5500 nm
- Design Cruise Speed . Mach0.75 0.85
- Take-Off Field Length .............2800 m
- Landing Field Length .............2200 m
- Time to Climb ..................30minutes
- Airport Compatibility Limits ..........
- ................................CAO Code 'F'
- ACN (Flexible B) ............70
- DOC Target ..............15% reduction on competitors
-

Achievements/Description
The ContainAir CA1 'Spartan' aircraft is a conventional high wing, high tail configuration with a maximum payload capacity of 194 tonnes on two loadable cargo decks. The main cargo deck can accommodate all of the standard containers and pallets, in addition to ISO style shipping containers and outsized cargo. The CA1 has superior range performance when compared to its competitors carrying 194 tonnes to 4950 nm, 178 tonnes to the 5500 nm design range and a ferry range of 10200 nm. Powered by four Rolls-Royce turbofan engines, with a sea-level static thrust of 98560 lbs, the CA1 climbs to ICA in under 25 minutes and cruises at Mach 0.83. The improved fuel consumption and increased payload capacity of the CA1 give an 8% reduction in DOCs when compared to the nearest competitor.

Designers:
- Christopher Brampton,
- Nicholas Leppard,
- Terence Lo,
- David Marchant,
- Jigar Patel,
- Laura Simpson,
- Andrew Bailey

Supervisors:
- Dr R Butler,
- Dr H A Kim,
- Dr G D Lock,
- Dr G Tilley,
- R G Outram,
- Prof JA Jupp,
- Mr M L Jukes,
- Mr N Wijker,
- Sir Robert Hill,
- Dr J Croker,
- A Langridge,
- M Ball

Support: Airbus UK, Rolls-Royce
Design Brief
Current estimates in the growth of the world air-freight market show substantial development of the large (>80t) & long range (3000nm+) sectors within the next 20 years due to increasing demand & existing fleet replacement. This potential growth combined with aging passenger converted freighters, struggling capacity of existing airports & infrastructure would require an aircraft with high payload capabilities combined with a range suitable for existing hub-to-hub freight networks.

Aim
The aim of this task is to design a dedicated high-payload freighter to meet the needs of the General Market Freighter operators on major routes with an entry into service date of 2020. Key design drivers are to meet the regulatory, economic and environmental needs expected by this date.

Specification/Key Issues
The aircraft must be capable of:

- Transporting a payload of 150-200 tonnes at a density of 12 lb/ft³.
- Meeting a design range of 5500nm.
- Flying within a Mach range of 0.75-0.85.
- Landing within a required field length of 2200m whilst at sea-level under ISA conditions at an approach speed of no more than 160 knots.
- Taking-off within a required field length of 2800m whilst at sea-level under ISA+15 conditions.
- Meeting all current large aircraft regulations, including ICAS-C*, CS-25 & OEI.
- An entry into service by 2020.

Achievements/Description of the Design
The final design is that of a conventional low wing aircraft utilising a squared-off elliptical fuselage to maximise its three deck internal capacity, allowing for fast turnaround times of an hour when combined with a nose loaded main deck and other suitable access doors. Featuring a MTOW of 550 tonnes and payload of 151 tonnes for its design range and 200+ tonnes for a typical operation range of 3000nm. The aircraft reaches its ICA of 36,000 ft within 20 minutes from 1500 ft and travels at a Mach of 0.84 throughout cruise whilst expecting a service ceiling of 44000 ft. Powered by four Rolls-Royce engines, each providing 82500 pounds of thrust. It can take-off at ICA+15 conditions Increased fuel efficiency & SFC due to an optimised altitude, laminar flow control and a total aircraft composite percentage of 65% have minimised DOC to 20% less than that of the current freigher aircraft in the market, the 747-8F.

Designers:
- Oliver Vistisen
- David Paton
- John McHugh
- Charlie Pope
- K H Ku

Supervisors:
- Dr R Butler
- Prof I Gursul
- Dr M Wilson
- Dr G D Lock
- Prof T Outram

External:
- Prof S T Newman

Sponsors:
- Airbus Uk
- Rolls-Royce

Large Commercial Freighter Aircraft
The Extra-Wide Ellipse (EWE) Team C

Design Brief
Current market trends suggest that the aerospace industry has the potential to triple in size over the next twenty years, with significant growth expected in the general freight market. It is predicted that a third of all new freighter aircraft will be large freighters capable of carrying payloads in excess of 80 tonnes. The majority of freighters in operation today are derivatives of passenger aircraft designs. Indeed, there have been no purpose-designed or 'dedicated' freighters developed specifically for the civil market in the last forty years. Because there is potential for a significant number of sales to be made in the general freight sector, the task has been set by the University of Bath and Airbus UK to design a new, large, dedicated freighter aircraft which will exploit this apparent gap in the market.

Specification/Key Issues
The large freighter aircraft is to have an Entry Into Service (EIS) date of 2020 and must adhere to the regulatory, economic and environmental needs of general market freight operators at this time. In addition the aircraft must meet the following specifications:
- Payload Capacity - 150 - 200 tonnes
- Payload Density - 12lb/ft³
- Design Range - 5500nm

Achievements/Description of the Design
AirPaca have designed the Extra-Wide Ellipse (EWE) aircraft with a high wing, T-tail and elliptical fuselage configuration. The EWE comprises of a wide, single deck, which has been designed specifically for freighter operations. Unlike current competition, the aircraft can transport all current main deck and under deck containers in addition to a highly marketable 'outsize cargo' carrying capability. The EWE can carry a 150 tonne payload the design range of 5500nm to appeal to the inter-continental market, and also transport the full 200 tonne payload a distance of 3800nm, thus also appealing to intra-continental 'trunk flight' operators. The Maximum Take-Off Weight (MTOW) of the aircraft is 570 tonnes and the Operating Weight Empty (OWE) is 207 tonnes. The overall length is 72.1m and therefore there is potential for stretched variants to be developed in future.

Designers:
- DJ Food
- DP Goode
- Dr M Wilson
- John McHugh
- Charlie Pope
- K H Ku

Supervisors:
- Dr R Butler
- Prof I Gursul
- Dr M Wilson
- Dr G D Lock
- Dr G D Tilley

Technical (Internal):
- Dr P A Chapman
- Mr M Ball
- Mr N Wijker
- Mr T Hewitt

Technical (External):
- Prof J C Stevens
- Mr S Newman
- Mr R Hill

Business:
- Sir R Hill
- Dr J Crocker
- Mr C Stevens
- Mr R J Outram

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

In the past, large commercial freighters have been converted passenger aircraft or derivatives of passenger designs. A dedicated large freighter design could potentially offer a step change in operating costs by removing features only beneficial to passenger operations. The aim of the project is to design a dedicated large freighter aircraft for General Market Freight Operators like Atlas Air or Cargolux, for an entry into service date of 2020.

**Specification/Key Issues**

The key design drivers are high operational reliability and maintainability as well as low operating costs. Also, the aircraft must be designed to meet the ACARE environmental targets for 2020. The design requirements are as follows:

- **Payload of 150 - 200 tonnes, net density of 12lb/ft³**
- **Design still air range of 5500nm**
- **Design cruise Mach number of 0.75 - 0.85**
- **Take-off field length of 2800m (sea level, ISA +15°), landing field length of 2200m (sea level, ISA)**
- **ICAO code !F” airport compatibility**
- **Compliance with JAR-25 and CS-25**

**Achievements/Description of the Design**

The PanOrbis F-200 Leviathan is a conventional high wing aircraft featuring a high T-tail. The aircraft fits within the ICAO code !F” limits, with a span and length of 80m. The triple deck fuselage is capable of carrying 200 tonnes of payload in a variety of standard containers and as a large nose door is installed, large oversized items can be carried, and turn around time is optimised. Also, the high wing design permits the use of a low undercarriage, keeping the fuselage close to the ground and making loading easier. The design is optimised for medium range missions of 3000nm with the maximum payload of 200 tonnes. The use of composite materials in the wing reduced the structural weight and aerodynamic features such as winglets allowed an increase in lift to drag ratio. Finally, an arbitrary improvement in engine technology and specific fuel consumption was assumed for the entry into service date. As a result, the operating costs of the Leviathan are predicted to be below those offered by competitor aircraft, in particular the Boeing 747-8F.

**Designers:**
- Michael Bailey, Alexander Hamlin, Akbar Khan, Simon McAleese,
- Hervé Hilaire, Ivan Li, Andy Liu, Roanne Perrin

**Supervisors:**
- Academic: Dr M Wilson, Prof I Gursul, Dr M J Carley, Dr J Vogwell,
- Dr D N Johnston Industrial: Prof J Jupp, Mr K Macgregor, Mr R Holliday,
- Mr A Langridge, Prof S T Newman, T Hewitt

**Sponsors:** Airbus UK, Rolls-Royce plc

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**Design Brief**

With the airfreight market predicted to grow at a base level of 6.1% globally between 2005 and 2025, a potential market has been highlighted that requires the design of a large freighter aircraft. A freighter specific design, as opposed to a passenger aircraft conversion, has the potential to reduce direct operating costs significantly and prove an attractive offer to airline operators facing retiring fleets. A future family of freighters should also be considered although is not a main driving impetus for design.

**Aim**

The technical aim of this project is to design an aircraft that best meets the specification given with the aim to reduce direct operating costs as far as practicable. An assessment should then be conducted to determine the feasibility of such a project. The academic aim of the project is to understand the technical and business processes associated with aircraft design.

**Specification/Key Issues**

- **EIS 2020**
- **Payload: 150 - 200 tonnes**
- **Design Range: 5500nm (average mission 3000nm)**
- **Take-off length / Landing length: 2800m / 2200m**
- **Airport compatibility limits ICAO code F**
- **Design cruise speed: Mach 0.75 - 0.85**
- **Direct operating cost reduction target: 15%**

**Achievements/Description of the Design**

With the EIS date of 2020 being a key design driver, the ‘Airhaul ORCA’ is a low wing, conventional design with cargo holds distributed over two decks. A large upper main deck accommodates many container and pallet types and also oversized cargo. It also has the ability to carry ISO type shipping containers in an effort to penetrate the sea shipping market of high value, time sensitive goods. The aircraft has an MTOW of 589 tonnes and is able to carry 187 tonnes over the average mission length of 3000nm. It is also able to carry 175 tonnes the full 5500nm design range specified. The aircraft cruises at mach 0.85 with an initial cruise altitude of 36,000ft climbing to 40,000ft in steps of 2000ft, meeting a time to climb of 30 minutes. The aircraft structure uses composites extensively throughout the wings and fuselage to reduce OWE and subsequently fuel burn. This low OWE results in a significant reduction of DOC’s over the 747-8F making the project a viable, profitable business venture.

**Designers:**
- Matthew Kedgley, Fred Nightingale, Nicholas Marshall, Henry Wong, Gordon Ho, Vishnu Narayanan

**Supervisors:**
- Dr R Butler, Dr M Wilson, Prof I Gursul, Dr M J Carley, Dr R G Outram
- Sir Robert Hill, Mr R Holliday, Dr J Crocker, Mr A Landridge, Mr C Stevens

**Support:** Airbus UK, Rolls-Royce
Project Sponsorship 2007-2008

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.

Smurfit Kappa UK, Waverider
Riverstation Restaurant
Advanced Transport Systems Ltd
ABB
Screwfix
Rencol Tolerance Rings Ltd
Airbus Filton
Rolls-Royce
Procare
Bath Institute of Medical Engineering
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

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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<tbody>
<tr>
<td>Ian Barron</td>
<td>Rolls-Royce</td>
<td>GDL</td>
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<tr>
<td>David Foord</td>
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<td>GDL</td>
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<tr>
<td>Ronald Lam</td>
<td>Rolls-Royce</td>
<td>GDL</td>
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<tr>
<td>Robert Lane</td>
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<tr>
<td>Shobia Santhiyago</td>
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<td>GDL</td>
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<tr>
<td>Christopher Thomas</td>
<td>Rolls-Royce</td>
<td>GDL</td>
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<tr>
<td>Alex Lazell</td>
<td>OC Robotics</td>
<td>STN</td>
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France

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<tr>
<th>Student</th>
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<th>Assessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rachel Eadon</td>
<td>Junior and Tacke, Munich</td>
<td>MW</td>
</tr>
<tr>
<td>Edward Hardy</td>
<td>Daimler, Stuttgart</td>
<td>MW</td>
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<tr>
<td>Collette Knill</td>
<td>Porsche AG, Stuttgart</td>
<td>MW</td>
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<tr>
<td>Gareth Lewis</td>
<td>MAHLE GmbH, Stuttgart</td>
<td>CJB</td>
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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.
Aerospace-Automotive Group

**Alderson, Helen**  
Supervisor: GP H C  
**Carbon and Environmental Footprinting of Low Carbon UK Electricity Transition Pathways to 2050.**  
A carbon and environmental footprint analysis of electricity consumption in the UK since 1950 and of projected electricity demand out to 2050 using SUPERGEN’s ‘Business As Usual’, ‘Low Carbon’ and ‘Deep Green’ scenarios was carried out. Comparison of the environmental impact of projections was made with regards to meeting the 2050 carbon emissions reduction targets and it was found that both the latter two scenarios would be effective if acted on immediately.

**Al-Harran, Omar**  
Supervisor: G P H  
**The Thermodynamic Implications of the End-use of Electricity for Heat and Power for the UK.**  
This project focuses on the thermodynamic implications of the end-use consumption of electricity for heat and power in the UK. It is wasteful from a thermodynamic point of view to convert fuels to electricity only to employ it later for heating. If the process or space heating is required then it is best to simply burn fossil fuels directly rather than using electricity. The data will be collected from BERR, MTP and SUPERGEN but will be modeled on SUPERGEN scenarios. The findings show that a major portion of electricity is still used in 2050 for heating but unlike today a more carbon friendly approach/technology is adopted.

**Baker, Neil**  
Supervisor: R B  
**Optimisation of Aerospace Composites for Damage Tolerance.**  
Composites are strong in-plane, but prone to delamination when subjected to out-of-plane impacts. For this reason a method of quickly estimating the failure strain of a damaged composite would be of great use. A program has been built that estimates the threshold strain or maximum allowable damage size for a given composite laminate. Further to this, a damage-tolerant laminate was manufactured, impacted and tested in compression to find its failure strain when exhibiting impact damage.

**Brown, Philip**  
Supervisor: M W S A M  
**CO2 removal from submarine compartments.**  
A ‘distressed’ submarine (DISSUB) situation means that the ‘active’ CO2 scrubbing system is disabled and passive LiOH curtains have to be used to remove the potentially dangerous CO2. The project aims were to produce a realistic model of the fluid behavior caused by the curtain within a sealed volume. A model had already created by a previous student and modifications were applied to this to improve for example the introduction of CO2 into the domain.

**Bailey Andrew**  
Supervisor: HAK  
**Two-Way Snap-Through of Bi-stable Morphing Structures.**  
A key area of ongoing research in the Aerospace Industry is the development of morphing structures technologies, for such applications as morphing wings and advanced control surfaces. Currently a variety of materials and possible methods of actuation and control are under investigation. One combination of technologies that has shown much promise is bi-stable composites and piezoelectric actuators. This project investigates how the two-way snap-through and morphing characteristics of a bi-stable laminate can be controlled using piezoelectric actuators.

**Cargo, Chris**  
Supervisor: J D D G T  
**Modelling of Power Plant Gas Flow.**  
The aim of the project was to create a dynamic model of the gas path in a power plant. This was achieved by creating a Matlab-Simulink model based on the Aberthaw coal fired plant. The model created was then used to simulate some of the possible fault scenarios in the plant and predict the system responses for different control settings to ensure safety.

**Cheng, Roy**  
Supervisor: M W  
**Propulsion Optimization.**  
The purpose of this study is to optimize the propulsion for a dedicated high-payload air freighter to meet the General Freight operators intended entry into service in 2020. Investigations have been carried out to compare the conventional turbofan and more advanced geared-turbofan engines in terms of fuel consumption, operating costs, noise and emission. It has proved the geared-turbofan engine has superior performance which satisfies the requirement from the next-generation engine.

**Davis, Anna**  
Supervisor: M W  
**Computation of Fluid-Structure Interaction.**  
This project examines computation of fluid-structure interaction (FSI) in the context of in-flight refuelling. Using ANSYS 11.0, the feasibility of simulating the deformation of the drogue canopy springs and the aerelastic effects of the drogue is investigated. A range of simulations are studied, these examine computation of deflections, unsteady flow and the necessary requirements to achieve realistic and accurate simulations.
Habgood, Stephen  
**Supervisor:** R B

**Experiments with Biodiesel: Vehicle Trials**

Biodiesel is seen as a potential substitute for fossil-fuel diesel in the Automotive Industry, with its advantages of a theoretical zero carbon footprint and renewable source. However, the effects on emissions and performance of a vehicle running on biodiesel need to be investigated.

This project looked into changes of emission levels and performance from vehicle testing on a chassis dynamometer when run on a blend of 5% biodiesel 95% fossil-fuel diesel compared to standard diesel.

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Hall, Simon  
**Supervisor:** JGH CB

---

Howard, Greg  
**Supervisor:** HAK JLC

**Can the Trabecular Architecture of the Fymoral Head be Predicted using Structural Optimisation?**

The link between applied mechanical loading and observed trabecular architecture has been studied since the 19th Century, most famously described by Wolff's Law, which encapsulated the idea that preferred trabecular orientation aligns with principal stress directions. This project applied Evolutionary Structural Optimisation (ESO) using ANSYS to the human proximal femur to successfully predict observed characteristic morphology.

---

Howard, Lawrence  
**Supervisor:** S A M

**Enhanced Cooling Techniques for Electronic Components**

“Thermal resonance” has the potential to enhance cooling of sensitive electronics. Cooling of a component was simulated under pulsating pressure waves and free-stream flows, optimising frequency, amplitude and channel blockage factor. Rate of cooling was monitored by computer, with convective flow structures visualised by dark-room schlieren imaging technique. Results showed that thermal resonance can produce up to 10x natural convection cooling, and is able to cool quieter than the equivalent finned radiator.

---

Hadjikyriacou, Savvas  
**Supervisor:** I G ZJW

**Flapping Wings**

A study of the effect, of small amplitude oscillations at low Reynolds numbers, on the lift and drag forces at a stalled NACA0012 airfoil was performed in a water tunnel. Considerable lift benefits, up to twofold increase of CL, were achieved with even small oscillating frequencies and amplitudes. It was shown that this increase was independent of the angle of attack provided that the airfoil was in a full stall condition.

---

Jazanovich, Micheal  
**Supervisor:** G DL

**Rolls-Royce Preliminary Design Optimisation of Exhaust System Cooling Holes**

Avoiding detection during surveillance missions is becoming an important design requirement, with engine operators demanding stringent low-observable specifications. With an increasing demand to reduce the IR signature of military engines, there is a greater emphasis on predicting exhaust temperatures at earlier stages of the design process. This project consisted on developing an automated, preliminary design optimisation tool able to predict thermal effects of effusion cooling within the exhaust system. A FORTRAN model was successfully developed.

---

Jones, Andrew  
**Supervisor:** A JG MJC

**The Aerodynamics of the Shell Eco-Marathon Vehicle**

The aim of the project was to gather aerodynamic data on the current setup of the Shell Eco-Marathon vehicle. With the current setup analysed, rudimentary modifications were applied to the vehicle to measure the amount of reduction in drag force that was possible. These rudimentary modifications were then redesigned for real world use. Finally a comparison was made with the previous Eco-Marathon vehicle to measure the improvements.

---

Khalid, Gona  
**Supervisor:** I G ZJW

**Aerodynamics of Membrane Wings**

Unique features displayed by membrane wings observed in the animal kingdom, and increasing interest in micro-sized aircraft has resulted in increased research activity on such wings. This project proposes the development and application of a setup that would allow measurements of the force normal to wing models of low-aspect ratio (flexible and rigid), at low Reynolds numbers over a range of angle of attack (from 0 to 35 degrees). The setup allows for three-dimensional models.

---

Kontouzoglou, Grigorios  
**Supervisor:** M McM

**Streamlined LCA of electricity distribution of overhead lines and related losses**

A streamlined Life Cycle Assessment (LCA) was conducted to determine the environmental impacts of overhead power lines (of distribution systems) in the UK. The study focused on Embedded Energy Input and Carbon Dioxide emissions. Three different conductor configurations were analysed (25, 38 and 100 sq mm). The results were compared to the transmission losses of each configuration in order to investigate whether or not an early intervention to the conductor's size would be environmentally beneficial.

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Jones, Andrew  
**Supervisor:** A JG MJC

**The Aerodynamics of the Shell Eco-Marathon Vehicle**

The aim of the project was to gather aerodynamic data on the current setup of the Shell Eco-Marathon vehicle. With the current setup analysed, rudimentary modifications were applied to the vehicle to measure the amount of reduction in drag force that was possible. These rudimentary modifications were then redesigned for real world use. Finally a comparison was made with the previous Eco-Marathon vehicle to measure the improvements.

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Khalid, Gona  
**Supervisor:** I G ZJW

**Aerodynamics of Membrane Wings**

Unique features displayed by membrane wings observed in the animal kingdom, and increasing interest in micro-sized aircraft has resulted in increased research activity on such wings. This project proposes the development and application of a setup that would allow measurements of the force normal to wing models of low-aspect ratio (flexible and rigid), at low Reynolds numbers over a range of angle of attack (from 0 to 35 degrees). The setup allows for three-dimensional models.

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Kontouzoglou, Grigorios  
**Supervisor:** M McM

**Streamlined LCA of electricity distribution of overhead lines and related losses**

A streamlined Life Cycle Assessment (LCA) was conducted to determine the environmental impacts of overhead power lines (of distribution systems) in the UK. The study focused on Embedded Energy Input and Carbon Dioxide emissions. Three different conductor configurations were analysed (25, 38 and 100 sq mm). The results were compared to the transmission losses of each configuration in order to investigate whether or not an early intervention to the conductor's size would be environmentally beneficial.

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Langmaak, Stephen  
**Supervisor:** M W G DL

**Computations of Gas Turbine Cooling Systems**

This project dealt with computations of the pre-swirl cooling system used in gas turbine engines. Research is currently investigating the effect of varying the pre-swirl nozzle location, represented as the inlet in a CFD model. During this project, a total pressure was specified at this inlet in order to capture the effect of varying pressures in the pre-swirl chamber. Different inlet geometries were also tested to obtain realistic inlet flow conditions.

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Littlewood, Rodger  
**Supervisor:** S A M

**The Effects of Forcing on Air Flow through a Wind Tunnel**

Novel methods to improve electronic cooling are being researched. Heat transfer and fluid mechanical aspects both need to be understood; this project investigates the latter. The interaction of streamwise flow and pulsed flow from a speaker were examined, with speaker amplitude and freestream velocity varied. The pulsed flow showed behaviour consistent with an impinging synthetic jet. The freestream was found to shift the pulsed flow downstream, the freestream remaining separate.

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Mudzabi, Badiatul  
**Supervisor:** DASR

**Unsteady Conduction in Bicomposite Media**

Knowledge of the inter-phase heat transfer coefficient, h has deterred usage of the two-equation model for conduction in porous media. By considering unsteady conduction, values of h are determined for either two-phaseds solids or stagnant porous media, as well as with a single fluid. The approach used is to match the average solutions of the detailed microscopic equations to that of the macroscopic equations and thus obtaining h the only remaining unknown in the macroscopic equations.

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Megevand, Rudy  
**Supervisor:** S A

**Hybrid vehicle powetrain simulation**

This project demonstrates the potential efficacy of an adapted battery State Of Charge control strategy using predictive information from the Global Positioning System (GPS) for a hybrid vehicle. The Matlab-Simulink based simulation ADVISOR 3.2 is used and a new Toyota Prius ADVISOR model is proposed. With this new model, the fuel consumption can be reduced by 8% during a given drive cycle. A possible adaptive control logic is then suggested to develop real adaptive control units.

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Mohan Talip, Tuty Arinah  
**Supervisor:** HAK JLC

**Can the trabecular architecture of the patella be predicted using Topology Optimisation?**

Bone is a hard, inhomogeneous structure. It responds and adapts to mechanical loading subjected to them. It is this bone’s ability to adapt that is the focus of this project. Evolutionary Structural Optimisation (ESO) using Finite Element Analysis to investigate whether or not an early intervention to the conductor's size would be environmentally beneficial.
Papke, Jennifer  
Supervisor: D.A.S.R.

"Microscopic Modelling of heat flux boundary condition in a bicomposite material!"

The aim of this investigation was to gain a fundamental understanding of the hydrodynamics of three pteraspid models, to lay the foundations for future investigations. The model was modified when using RME can be increased by modifying the start of injection.

Ramos Tomás, Ricardo  
Supervisor: D.A.S.R.

The Dual-Temperature Model for Forced Convection in Porous Media

Porous media have been under investigation for nearly five decades, but there have been no papers explicitly dealing with the effect of fluid phase velocity on the inter-phase heat transfer coefficient. The project investigates the impact of variances in the fluid\'s Péclet number, the solid-fluid contact temperature and the micro-structure of the fluid phase velocity. These are used to determine the h.t.c. for each set of variables, to explore the existence of a correlation.

Seow, Yuen Eng  
Supervisor: R.B.

Optimization of Composite Laminates for Buckling and Manufacturing

Parametric studies for tow placed designs are performed using VICONOPT to analyse the buckling load capability. The buckling results are compared with traditional straight fibre laminates. Manufacturing techniques for tow placed designs are studied. The second objective of this project is to investigate the micromechanics of the materials, thickness design variables subjected to load constraints. Mass savings between aluminium and composite materials are calculated. Optimum thickness distribution for variable thickness analysis is also discussed.

Singh, Kabir Rai  
Supervisor: G.D.L.

Application of Thermochromic Liquid Crystals to the Study of Film Cooling

The design of cooling systems in turbine blades exposed to extreme temperatures has long been an area of competition amongst jet engine manufacturers. The project looks at the application of thermochromic liquid crystals to measure the behaviour of cooling air used to protect the surface of these blades. Experiments were carried out in a wind tunnel to determine film cooling effectiveness. Understanding cooling behaviour through experimentation supports CFD modelling and ultimately helps develop more efficient engines.

Stern, George  
Supervisor: I.A.K.

Analysis Methodology for Aerelasticity

A FORTRAN program that used the dynamic stiffness method and the Wittrick-Williams algorithm to model the aeroelasticity of a composite wing was studied. Time was spent to understand the program so that parts could be validated and its overall structure mapped out. An attempt was made to find the flutter speed by linking the aerodynamic and structural parts of the program which had been left incomplete. This was not completed due to runtime errors.

Taylour, Richard  
Supervisor: M.J.C.

Noise from Novel Aircraft Configurations

With airports becoming busier and consequently noisiest, one of the primary design factors for commercial aircraft is now minimum noise. An investigation was made into the noise abatement effects of wing shielding and airframe embedded engines using an novel boundary element method of acoustical calculation. In particular, it was investigated at which height above the wing, axial position of nacelle and amount of nacelle-airframe embedding would prove most effective in noise abatement.
This project involves the design and manufacture of CFRP coupons before testing under four point bending to investigate the propagation of delaminations in the laminate. Impacting the coupons using a drop test machine simulates Barely Visible Impact Damage (BVID) and delaminations are investigated using NDE technologies: photomicrograph, Ultrasonic C-Scan and Digital Speckle Photography. The results suggest a critical delamination depth for thin film buckling and beyond this limit it was discovered that interlamellar cracking occurs.

Investigation into the Aerodynamic Effects of the Praying Mantis Position in Cycling Time Trials

In cycling, where seconds can mean the difference between winning and losing, aerodynamic optimisation is vital. The praying mantis time trial position is known to reduce drag for some athletes but increase it for others and it was not known why this happened. Via a revolutionary CFD technique, wind tunnel experimentation and field tests, it has been shown that several notable changes that occur when adopting the mantis position for a range of anthropometric parameters.

Optimisation of a Milner CVT

A Milner CVT is a novel form of continuously variable transmission which has the advantage of being simple, light and compact. The concept is in its infancy and very little development work has been done. This project used MatLab to model how several key performance criteria changed with alterations to the geometry. Design of Experiments techniques and optimisation routines were used to determine the most optimum solutions in each case.

Thrust Generation with Membrane Oscillations

An experiment was conducted to investigate the thrust generating capabilities of an oscillating membrane. The objectives were to see if these oscillations could be induced and controlled through a mechanical input, to determine any thrust that the membrane oscillations generated, to use flow visualisation to look at the generation of trailing vortices by the oscillating membrane and to see if theoretical models could be used to predict the amount of thrust an oscillating membrane would produce.

Climate change adaptation in the Bath and North East Somerset region

As the global climate changes, resulting consequences are currently being felt worldwide. Bath and North East Somerset will gradually experience a resulting increase in temperatures and decrease in precipitation levels. This study focuses on the adaptation of residential and historical buildings through space energy efficiency improvements. The employment and potential benefits of roof, cavity wall and window insulation in residential buildings are analysed, resulting in energy improvement efficiencies, economic payback periods and climate change adaptation suggestions.

Drogue spring flutter

This is an experimental based project to investigate the aerodynamic instability flutter occurs in refuse drogue during flight refuelling. An experimental test rig was utilized to obtain oscillation data in wind tunnel at difference speed and angle of attack to gain some experience of flutter. During the test, three difference torsion spring and two difference profile shape test plates were utilized to compare the occurrence and peak to peak angle of flutter.

Automated Aerospace Wing Assembly

Higher aircraft demand is driving aircraft manufacturers to consider automation strategies. Flexible automation and industrial robots have been elected as suitable. Adaptive control using non-contract metrology are required to bring the potential benefits of the industrious robots within aerospace requirements. The use of composite components will aid automation through reduced part counts but hinder it through low part interchangeability. An automated assembly line is presented which aims to solve these issues.

The Potential Benefits of Dynamic Timetabling of Public Transport

Public Transport is a fundamental aspect of people’s lives and their quality. The requirement to provide high quality transport in the context of mobility for all is an issue governments and authorities are concerned with worldwide. Current public transport networks are no longer adequate to meet the new expectations of the general public. This research is an effort to investigate the potential benefits dynamically scheduled transport systems may deliver to both the population and the environment.

Modelling the performance of engineering systems

The aim of this research project is to investigate the application of the University of Bath’s constraint modeller to a typical design problem of a la yaw system.

It can be divided into two parts. Firstly the traditional paper-based approach is implemented to the constraint modeller discussing the necessary equations for the design of the system and validating the implementation. Secondly the implementation is transformed to a constraint-based approach.
The DNA of a Document

Recognising the importance of credible information to the product design process, the project aims to establish a method for recording the ingredients, or 'DNA', of a document, so that such information may be linked, and subsequently traced, to its origins and sources. An empirical investigation is revealed to show how documents develop in an informational nature during design activities. Focus is also given to the contextual elements complementing rationale capture, which subsequently addresses how engineers evaluate their use of information.

Li, Weijun
Supervisor: RIM
Optimising distribution centre design by simulation

A novel conceptual design for a fully automated warehouse is being developed at the University. This concept can be extended to an automated supermarket, to confirm its capability and to investigate variables that may affect the system's performance.

McNee, Emily
Supervisor: BJH
Design of a Continuous Form-Fill and Seal Machines

The aims of this project are to design a continuous vertical form fill and seal machine, where the out of balance forces are minimised. The design is tested by running a process that has shown significant fluctuations in the machine. The process is monitored by using statistical design and the survey looks at email usage effects on design engineer's work from technical support effects and psychological effects.

Munter, Oliver
Supervisor: PGM
A technical review of head mounted displays, their applications and potential for use in aiding with assembly

Recently there has been a great surge in the interest in using head mounted displays for use in a variety of industries. This project examines different head mounted displays, their current applications and whether or not they can be adapted for use in assembly. Different input peripherals and virtual environments were also considered. On total three different systems were recommended: A basic data display system, a 3D overlay system and an integrated digital manufacturing system.

Nash Andrew
Supervisor: LN
Simulation within a Manufacturing Test Facility

Scheduling in a job shop manufacturing facility is an important function, aiming to ensure a company maximises efficiency and throughput in order to maximise profitability whilst satisfying customers? varying demands. This project identified a particular approach and tries to improve it by investigating alternative methodologies using computer simulation based on industrial data from the company. It is hoped a general scheduling approach can be identified for use in future scheduling operations.

Nichol, Jack
Supervisor: FHO
Investigation into the Fracture Modes of Thin Metallic Layers

Impact testing was undertaken on thin sheets of aluminium alloy Al2024-T3 to characterise its impact behaviour. An existing data analysis and a program, called LS-DYNA, was used to approximately simulate the drop test experiment.

Owen-Jones, R
Supervisor: FHO
Energy Absorption in Impact Landing

The UREAD (Universal Reusable Energy Absorption Device) is a new concept that could be used on aircraft undercarriage to absorb large impacts. New UREAD designs and an assembly in which the UREADs could be operated sequentially were created. Static and dynamic loading tests were performed on the assembly, with the conclusion that the UREAD assembly performed as expected, was effective as an energy absorption device, and capable of use in aircraft to absorb impact on heavy landings.
Sowden, Martin  
**The Impact of Human Attributes on Walking Worker Simulation**

The aim of this project was to investigate the possible discrepancies between the performance of manual assembly systems at simulation stage and the performance of the same system after implementation. A portion of the errors generated could be attributed to the simulation software's inability to accurately model the inherent differences between worker performances. To improve the simulation's capacity to model humans in the system, a framework was generated to adapt worker performance relative to their capabilities.

Cheung, Harry  
Zhang, Zi Liang  
**Technology Management in the Aerospace Industry**

This project has developed an UML metrology classification framework. This model is developed on an iterative process suggested by the unified process methodology in object oriented programming. Alongside with the UML metrology framework, diagrams have been drawn to model software architecture of the Stage I MPM as described in the Large Volume Metrology Process Models journal. This metrology classification provided a detailed model that enables further advance on Metrology Process Model.

Hou, Yi  
**Correlation of Measured and Predicted Performance Data for a Formula Student Engine**

This project involves a comparison between performance data taken from previous dynamometer testing of a Formula Student engine and predicted data obtained through using the engine simulation software Ricardo Vow. The Formula Student engine experimented with is a Yamaha YZF-R6 600cc engine taken from a road going sports-bike. Performance data such as Power and Torque have been captured and compared with each other in order to investigate the impact of the two methods on performance data.

Zhang, Zi Liang  
**Comparison of CNC Programming Systems**

This project will compare the similarities in definitions of three high-level CNC programming systems (Heidenhain SmartTNC, Siemens ShopMill and DP technology ESPRIT). The aim of the project is to compare the 3 systems by programming of a set of benchmark parts based on typical features (pockets, slots, ribs) used in aeroplane industry. A secondary goal would be to identify possible methods to enable manufacture of such parts seamlessly on the different CNC machines based on the comparison.

Afonso, Dominic  
**Optimisation of a CBR600R transmission for Team Bath Racing 2009**

The gear train is an area of Formula Student car design that has, historically, been neglected at the University of Bath. Data logging of the outstanding performance of TBR07 at last year's Formula Student event has opened the door for the gear train of TBR08 to be optimised to truly suit the requirements of a Formula Student car. This report aimed to optimise the TBR08 gear train through careful selection of both final drive and internal gear box components.

Bleach, Jason  
**Computer Based Design For Changeover (DFC) Tool**

This report documents the findings of a final year project that was conducted to optimise the chassis performance of this year's car TBR08 which has yet to be manufactured. The project considered various aspects of the cars suspension system with particular consideration given to wheel and roll rates. Techniques such as static geometric analysis as well as practical experimentation were used and a specification for this year's car TBR08 has now been laid out.

Cheung, Harry  
**Formular Students Group**

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Kleister, Paul  
**Chassis Skinning-Modelling With FEA**

This project examines three different biodegradable polymers and their properties specifically for use in form fill and seal machines. A comparison was made between materials that are currently used in form fill and seal machines such as polypropylene and new biodegradable materials. The feasibility of using these new materials was evaluated taking into account material performance, properties, material interaction with the form fill and seal machine, cost, safety and life.

Schlight, Nicole  
**Sealing and Biodegradable materials**

This project investigates the potential of bioplastics in the packaging market compared to conventional petro based plastics. Little research has looked into the material interaction with plastic film, fill and Seal machines incurring large setup costs. Relevant material properties were also investigated along with their behaviour over forming shoulders in VFFS machines.

Reid, Stuart  
**Technology Readiness Levels (or TRLs) are an increasingly popular measurement system devised by NASA to assess a technology's development status or ‘readiness’ against its intended application. This project reviewed the current approaches towards their use and through a detailed case study identified key limitations in their application with commercial products and continually evolving technologies. New metrics were thus proposed extending TRLs to account for existing technologies whilst integrating them with a generic product development process.**

Royce, Jonathan  
**Implementation of Fuel Injection and Steady State Calibration of a Honda CBR600R Engine for Formula Student**

Bath’s 2008 Formula Student team have selected a new Honda CBR600RR engine. This project aimed to prepare and calibrate the engine for its very specific application. The project has developed an UML metrology classification framework. This model is developed on an iterative process suggested by the unified process methodology in object oriented programming. Alongside with the UML metrology framework, diagrams have been drawn to model software architecture of the Stage I MPM as described in the Large Volume Metrology Process Models journal. This metrology classification provided a detailed model that enables further advance on Metrology Process Model.

Yi, Hou  
**Design of a Customised Orthotic for Footballers**

An orthotic insole is an insert for people's shoes that allows improved biomechanics during their walking, running, or athletic movements. This project aims to generate a customised orthotic insole based on an Adidas Predator insole by using the PowerSHAPE CAD system. The purpose was to demonstrate how a CAD system could be used in designing a customised orthotic for footballer. The Adidas Predator insole was reverse engineered by using PowerSHAPE and successfully generated a CAD representation of the sculptured insole.

Cheng, Harry  
**Formular Student Car Suspension and Steering Optimisation**

The aim of this project was to improve the suspension and steering performance of the Formula Student car through analysing the spring damper units theoretically and optimising the steering design with the use of tyre data. A Damper Dynamometer testing was performed to study the suitability of the new units with the Formula Student application. A modification on the last year car was made to apply the mountain bike dampers for vehicle testing.

Curtis Daniel  
**Sealing and Biodegradable materials**

With landfill sites getting filled worldwide with plastics that take hundreds of years to degrade, biodegradable alternatives should be firmly on the agenda. This project looks into the potential of bioplastics in the packaging market compared to conventional petro based plastics. Little research has looked into the material interaction with plastic film, fill and Seal machines incurring large setup costs. Relevant material properties were also investigated along with their behaviour over forming shoulders in VFFS machines.

Bleach, Jason  
**Sealing and Biodegradable materials**

With the Formula Student event becoming more competitive each year, any significant performance gains need to be seized upon. The composite skinning of the chassis investigated in this research report is one such performance enhancer. Flexibility in TBR07 chassis resulted in poor steering feel, with the addition of a composite chassis skin to TBR08 torsional rigidity has dramatically improved. A technique that is predicted to become increasingly prevalent in the future of the competition.

Griffiths, Eric  
**Correlation of Measured and Predicted Performance Data for a Formula Student Engine**

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Lane, Andrew  
Supervisor: KR  
**Design and Build of a Flow Bench for Characterising Engine Breathing**  
A flow bench has been designed and built to characterise the breathing of TBR’s previous and current engines. Flow coefficients were obtained for three different 600 cc motor cycle engines and various components of the intake system. It was found that flow was most efficient through the two main branches of the intake restrictor, however an additional branch to the intake restrictor had a considerable impact. From the data obtained, recommendations have been made and input data provided for Ricardo WAE simulations.

Siddy, Ian  
Supervisor: A J G  
**The Design and Manufacture of Carbon Fibre Wheel Rims**  
To develop Team Bath Racing’s entry into Formula Student 2008 a study was undertaken to reduce the unsprung mass of the vehicle by designing carbon fibre wheel rims. The study investigated the processes and techniques used to produce composite wheels before designing and manufacturing a prototype rim. Evaluation was then carried out on the prototype rim in accordance to SAE industry standards to determine whether it was suitable to run on the 2008 car.

Grice, David  
Supervisor: W M  
**Design of a Kite Powered Kayak**  
The use of kites as a means of wind powered propulsion offers many possible advantages over a typical sail powered design. This project covers the design, manufacture and initial testing of a kayak that has been modified to use an inflatable kite surfing kite for propulsion. A trimaran based design was manufactured using three kayaks which incorporated a variable attachment point to help steer the boat without the use of a rudder.

Vinall, Rick  
Supervisor: KR  
**Simulation of possible future development concepts of Honda CBR engine for a Formula Student application**  
The aim of this project was to investigate possible future development concepts that could be applied to the Honda CBR 600 engine. The concepts investigated were supercharging, turbocharging and using E85. Ricardo WAE was used to simulate these concepts and optimise their performance. The results suggest that turbocharging would be the most viable option as it produces an improvement in power and torque, as well as fuel consumption.

Lewis, Andrew  
Supervisor: C J B  
**Cell Installation and transient optimisation of a Formula Student engine**  
The aim of this project was to develop and implement a repeatable and reliable test procedure to optimise the transient performance of the formula student engine, in addition to upgrading the formula student test cell facilities. This is a vital part of the engine calibration process, without transient control there would be poor engine performance during changes. This would lead to irregular power delivery, resulting in poor vehicle driveability.

Morton, Peter  
Supervisor: G W O  
**Vehicle Dynamics of a Historic Racing Car**  
The aim of the project is to validate the use of modern racing car lap simulation software on a historic racing car. The required data was gathered by means of experimentation and measuring before being entered into the software. The simulation results were analysed and any performance enhancing set up changes suggested. Finally the suitability of using the software for such an application was assessed.

Abdul Rahim, Sharafiz  
Supervisor: A J H  
**Dynamic Modeling of a Damaged Oil Platform**  
This paper details firstly the finite element analysis using ANSYS program for the intact offshore structure. The dynamic response in nodal displacement is obtained using a single degree of freedom in X and Z-direction. Finally, the displacement responses at the selected nodes are compared for both intact and damaged structures. The results obtained from the system transfer functions and frequency response show that the natural and resonance frequency of the undamaged structure are significantly higher in comparison to the damaged structure. In conclusion, damaged and undamaged oil platform structure can be differentiated by dynamic modeling simulation.

Bryant, Andy  
Supervisor: P I  
**On the Design of Emergent Engineering Structures, with an Application to Swarm Robots**  
Social insects such as ants, termites or bees exhibit cooperative behaviour which is inerit in complexity to that of any individual, and which possesses other useful characteristics such as robustness and flexibility. This project studies how these useful characteristics could be imitated in a swarm of small robots, demonstrating how these robots could be programmed with simple behaviours that resulted in the self-organisation of engineering structures such as towers or bridges.
The Performance of Active Valves

Clark, Andrew  
Supervisor: P S Keogh / D G Tilley  
D N Johnston / C R Burrows

Optimising the power take off for a wave energy converter

This project concerns optimising the efficiency of a wave energy converter. The modelling and optimisation were done using Matlab Simulink. The efficiency of the converter was optimised by the use of the most suitable components as well as identifying and improving sources of loss. The converter was optimised to wave condition of 1.5 m amplitude and 10 seconds period.

Moyers, Joseph  
Supervisor: D G Tilley  
D N Johnston

Modelling and Simulation of a Hydraulic Valve

This project, supported by the Honda Racing F1 Team, presents a simulation software written in the MATLAB environment that efficiently predicts the optimum racing line around a Grand Prix circuit for a point mass vehicle model. The problem was solved using a quasi-static lap simulation and particle swarm optimization theory. An investigation into the effect that vehicle parametric changes (e.g. grip, power, mass and aerodynamic characteristics) had on the optimum racing line calculated was performed.

Lee, Choon long  
Supervisor: P S Keogh

Thermal Prediction for Journal Bearings

Thermal prediction is essential for journal bearings as failures are mostly due to hydrodynamic lubrication inefficiency leading to bearing metals overheating and seizure. An analytical model was constructed in this study based on thermo-hydrodynamics to compute a temperature distribution of the bush and lubricant. Heat transfer was incorporated into the model to create a more realistic boundary condition to the assumption of adiabatic condition. This was achieved by MATLAB simulation and compared with previous findings.

Piperakis, Alexander Spyro  
Supervisor: D G T  
D N J

Project Synopsis: Shoshling of Aircraft Fuel in a Tank

Shoshling is the back and forth splashing of a liquid fuel in its tank. In aircrafts, fuel shoshling causes a number of problems, such as altering aircraft stability, endangering the fuel tanks structural integrity, increasing fuel volatility due to fuel and air mixing, etc. The objective of this project is to develop a CFD shoshling model of a rectangular tank, and validate it experimentally. In addition, the effect of baffles in the tank will be examined.

Given, David  
Supervisor: A R Plummer

Optimum Racing Line Calculator for a Formula One Car

This study focuses mainly on an instability which had been discovered within a racing valve produced by the Sun Hydraulics Corporation. A dynamic model of the valve was created in MATLAB SIMULINK, with the aim of finding the cause of instability within the whole valve. After extensive testing of the model, a number of conclusions were drawn. From this, recommendations were made with the view of improving the valve design in order to reduce instability.

Patek, #cska

Modelling of Aircraft Fuel System

The general aircraft system is complex, dynamic and nonlinear. These are all factors that make diagnosis complicated. The aim of this project was to develop physics based model of a generic aircraft fuel system for the purpose of fault detection and control logic studies. The development was to be carried out in the MATLAB-Simulink environment. The developed algorithms provide fault condition estimates that allow for consistent detection of faults and abnormal conditions. A simple fuel tank animation was also developed.

Lee, Ka L

The Performance of Annular Seals

A repeatable procedure with an accuracy of ±5% was developed to measure the friction force of a pressurised rod seal. The test results were used to check the Stribeck predictions, and that the double lipped seal produces less friction than the single lipped seal.

Small, Rachel  
Supervisor: P K, D G T, D N J, C R B

The Performance of Annular Seals

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Sollars, Stephen  
Supervisor: D G T  
D N Johnston

High Speed Trailer Stability

The project concerns the dynamics of trailer oscillations at high speed, and an investigation into a safety device available on the market, the AL-KO Anti-Trailer Controller (ATC). An experiment was performed to quantify the brake torque applied in emergency situations by the ATC, and MATLAB’s Simulink package was used to model the car trailer system and determine the factors affecting oscillation. New safety controllers were also devised and tested for effectiveness.

Thrasyvoulou, Antonis  
Supervisor: D G T

Analysis of a Scaled Car and Trailer Model

Accidents involving cars towing trailers happen under very similar circumstances, where an initial impulse at high speed causes the trailer to start swaying about the hitch point. Aim of this project is to use a scaled car-trailer model to identify how sensitive the system is to variations of the cars geometrical and physical properties. The experimental results are then confirmed with the use of a previously developed and validated computer simulation model.

Structures and Bioengineering Group

Barker, Helen Frances  
Supervisor: AWM

Lag Screw Cut-Out in Osteoporotic Bone: A Laboratory Investigation

The objective of said investigation was to observe the relative degree of cut-out resistance demonstrated by the Dynamic Gamma-3 nail and Proximal Femoral Nail Antirotation device demonstrated the best resistance to the phenomenon of cut-out.

Brain, Nick  
Supervisor: J F V V

Biomimetic Materials Processing

The task was to verify two graphs produced by Professor Vincent which detail the difference in the manner with which biological and traditional engineering solve problems. This was done, other related areas of interest were explored, and conclusions drawn. There is a need for considerable cross-university level work in this new but very important field. Potentially, work in this area could fundamentally change engineering as we know it today.
Cash, Philip
Supervisor: JF W
Deployable Tree as Art
Focusing on the study and application of deployment mechanisms and the governing biological scaling factors used by the plant Anthriscus Sylvestris a kinetic sculpture was conceived. Deployment mechanisms were used to design and build a collapsible sculpture based on the natural growth and structure of the plant. Combinations of telescopic and folding mechanisms were used to achieve the design targets. These gave a final deployment range achieved of three metres and an ultimate height of over five meters.

Curson, Philip
Supervisor: JLC
The Effect of Callus asymetry on the Mechanical Properties of a Healing Fracture
Fracture healing is a complex process governed by many internal and external factors. An objective measure of healing is necessary to guide the healing process. Most fractures result in a bony growth of material around the fracture site known as a fracture callus. This callus will rarely heal symmetrically as the effect that the asymmetry has on its mechanical properties is unknown. This paper investigates the effect of callus asymmetry using the finite element method.

Chau, Jason
Supervisor: AW M
Project title: Hinged knee study
Population ageing is a global issue, leading to high demands on joint replacements. Knee replacement is one of the most commonly performed procedures worldwide. This project focused on investigating the rotational properties of four rotating hinged knee prostheses which are commonly used.

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Supervisor: AW M
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Carson, Philip
Supervisor: JLC
The Effect of Callus asymetry on the Mechanical Properties of a Healing Fracture
Fracture healing is a complex process governed by many internal and external factors. An objective measure of healing is necessary to guide the healing process. Most fractures result in a bony growth of material around the fracture site known as a fracture callus. This callus will rarely heal symmetrically as the effect that the asymmetry has on its mechanical properties is unknown. This paper investigates the effect of callus asymmetry using the finite element method.

Curzon, Philip
Supervisor: JF W
Deployable Tree as Art
Focusing on the study and application of deployment mechanisms and the governing biological scaling factors used by the plant Anthriscus Sylvestris a kinetic sculpture was conceived. Deployment mechanisms were used to design and build a collapsible sculpture based on the natural growth and structure of the plant. Combinations of telescopic and folding mechanisms were used to achieve the design targets. These gave a final deployment range achieved of three metres and an ultimate height of over five meters.

Chau, Jason
Supervisor: AW M
Project title: Hinged knee study
Population ageing is a global issue, leading to high demands on joint replacements. Knee replacement is one of the most commonly performed procedures worldwide. This project focused on investigating the rotational properties of four rotating hinged knee prostheses which are commonly used.

Carson, Philip
Supervisor: JLC
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The aim of this project was to design a fluid dispenser that would allow older people to obtain fluid independently, thus eliminating the risk of dehydration when a carer or nurse is unavailable to help. A low effort lever is used to dispense a single cup of fluid, which prevents those with poor eyesight from overfilling their cup. In testing, this project was shown to be an intuitive and effective solution to the problem.
Ranscombe, Charles
Supervisor: SJC
SEE SENSE, Intelligent Lighting
The brief was to design an intelligent lighting system that was affordable and retrofit-able to existing lighting. The system was aimed inclusively at the elderly and disabled as well as homeowners. The product designed is a safety light adapter, one device from a proposed range of three. It uses motion sensing and timer functions to automatically change the environment when required including an easy to operate interface while being as small and unobtrusive as possible.

Rosley, Ahmad
Supervisor: SJC
Micro Electricity harvesting for shower LCD Display
Synopsis: The aim of this project is to have a LCD display or LED indicator that will display useful information while taking shower such as temperature, flow rate and water pressure. The LCD display should provide the power supply locally instead of being connected to external power supply. At this moment, the project focuses on harvesting energy from the flow of water to generate sufficient electric current as required which is around 41 mA.

Simmonds, Oliver
Supervisor: WMM
Underwater Remotely Operated Vehicle: Key Components and Accessories
This project is one half of the development of an underwater remotely operated vehicle for use in coastal, tidal and high current environments by scientific research institutions and small commercial organisations. This project discusses the key components and accessories of an underwater ROV including the thrusters, lights, camera and umbilical cable connecting the ROV to the surface. The units were designed using analytical methods, developed using computer software and successfully tested in both the pool and sheltered open water.

Simpson, Patrick
Supervisor: JD
Multi Terrain Wheelchair
This project aimed to build a bespoke multi terrain wheelchair for a girl called Hero Joy Nightingale who suffers from a neurological locked-in condition. The chair developed, Cheero 4, offers huge advantages over a conventional wheelchair in terms of adjustability and off road performance. Its key features include a reclinable seat, rickshaw poles and a fold back footrest to facilitate easy transfer in and out of the chair.

Waters, Nathan
Supervisor: EAD
Eco Greenhouse Heater
The aim of this project was to design a system capable of heating a greenhouse in an environmentally friendly way. The project involved designing, building and testing a system that can be retrofitted to existing greenhouses. The system was able to reach temperatures of 15°C, which is sufficient to maintain the environment when required. The system was also designed to be compact and unobtrusive.

Driscoll, Heather
Supervisor: JVD
Measurement system for effect of cricket ball condition on movement through the air
Investigation into the aerodynamics behind the flight of a cricket ball, resulting in the design and construction of a small scale low speed wind tunnel with working instrumented test section. The test section consisted of a strain gauge system and was used to measure and record the side forces as a function of ball condition along with an experiment procedure that demonstrates the load bearing responsibility of every spoke within an 8 spoke radial wheel.

Brookes, Matthew
Supervisor: JVD
An Investigation into Effects of Spoke Fastening on Racing Wheel Loads
This aim of this investigation was to explore the design factors that contribute to the radial stiffness of high specification racing wheels with radial spoke formations, through a structured experimental programme. A method for calculating the second moment of area for any wheel rim has been developed along with an experimental procedure that demonstrates the load bearing responsibility of every spoke within an 8 spoke radial wheel.

Wesley, Hayley
Supervisor: MMCM
A Biodiesel Transmethylation Plant for Pabal, rural India
In India, access to energy is unequal and the aim of this investigation was to develop an appropriate production method to manufacture a reliable fuel source for the rural Pabal community. The result was a very simple, $40 gravity-driven plant that minimised the use of mechanical components and was sourced from local materials and scrap. This project culminated with a three-week visit to Pabal to implement the design and a batch plant of 12,000 litres annual output was the result.

Chalk, Jack
Supervisor: CB
Bio mimetic Formation of Calcium Hydroxapatite on Hydrogels
"An investigation into the magnitude of the forces felt by the hands of the batsman when striking a ball bowled at 100mph. In this project, the objective was to understand the forces felt in the hands of the batsman. The significance of the centre of percussion of the bat was also investigated."

Clayton, Ricky
Supervisor: MM
Bird Strike on Aircraft Structures
Bird Strike on Aircraft Structures was designed to test the capabilities of ANSYS/LSDYNA to model high velocity impact. Firstly, a bird model was verified against empirical data from other programs. Once verified the bird model was used to test a composite winglet to further test the abilities of ANSYS/LSDYNA. The capabilities of ANSYS were also compared to the capabilities of LS PREPOST.

Davies, Samantha
Supervisor: JVD
Colour development in anodised and thermally treated TiO2 films
An investigation into the effects of enhancing the natural oxide layer growth of titanium by means of thermal and anodisation techniques thus creating colour using the interference effect.

Animashaun, Alexander
Supervisor: MPA
Instrumentation for Force Measurement
A new system was designed and built to measure the dynamic characteristics of a track sprinter in the starting blocks. It was trialled on a group of elite sprinters and found to measure the impulse, athlete exit velocity and force exerted by each foot separately with an uncertainty of ±15. The reaction times were measured with ±2 ms uncertainty and were shown to be more accurate than an official reaction timing system.

Brookes, Matthew
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Elton, Matthew
Supervisor: CRB
RS
Shock Loads in Cricket Bat Handles
"An investigation into the magnitude of the forces felt by the hands of the batsman when striking a ball bowled at 100mph. An analytical model was also created by finite element and CAD means as a method of modifying the bat to see the effect that changes would have on the forces felt in the hands of the batsman. The significance of the ‘centre of percussion of the bat was also investigated.’"
Rapid curing of CFRP aerospace components

At present aerospace composites are typically cured by autoclave to produce high quality parts. This process can be very slow so there is the need to develop alternative rapid methods. This project contains a literature review of the current rapid curing methods available and associated technologies, followed by the design of a new 'luggage' process. This process developed by Airbus UK forms the basis of an experimental programme and thermal model for the project.

Bistable Structures

This project investigates bi-stable composites. These composites are thin, unsymmetrical laminates that do not conform to classical lamination theory. Two stable shapes are formed from bi-stable laminates and it is possible to 'snap' between shapes. A computational model was developed using current bi-stable theory to predict the behaviour of the laminates. Temperature curvature tests were carried out and successfully validated the model. The tests also allowed the calculation of the laminates thermal expansion coefficients.

Measurement of the Impact Forces between Pharmaceutical Tablets

A pharmaceutical tablet is subjected to many impacts during its lifetime, occasionally the drug containing core is exposed during manufacture. The investigation into the impact forces between drug containing tablets was carried out and the impact forces were recorded and then used to simulate the forces on tablets in the oral cavity. The experiment proved that there is a strong positive correlation between striking angle and impact force.

The Effect of Pressing Pressure on the Mechanical Properties of Natural Fibre Composites

An investigation into ferroelectret technologies has been made, identifying the processing parameters that improve bubble formation and piezoelectric activity. The main aim of the project was to identify methods of improving the size and consistency of the piezoelectric d33 coefficient (a measure of charge per unit force). The advantage that ferroelectrets have over the more common stiff and brittle ceramic piezoelectrics is their improved flexibility and lightweight structure thus enabling them to be used with a wider range of materials and shapes.
**Stewart, Richard**  
**Assessor:** C. A. McMahon  
**Supervisor:** Peter Burggraf, WZL, RWTH Aachen, Germany  
**Experimental Testing of an Electro-hydraulic Variable Valve Train**  
An electrohydraulic valvetrain is one of the most promising technologies for replacing fixed geometry valvetrains in internal combustion engines. By electronically controlling a hydraulic actuator it is possible to introduce new and advanced combustion strategies, which play a large role in reducing tailpipe emissions and vehicle fuel consumption. During this project such a system has been evaluated in terms of current performance criteria and as an enabling technology for more advanced combustion processes.

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**Stewart, Richard**  
**Assessor:** C. A. McMahon  
**Supervisor:** Peter Burggraf, WZL, RWTH Aachen, Germany  
**Analysis and Integration of Models within the Digital Factory**  
The concept of a digital factory offers an approach for enhancing product and production engineering processes in industry by integrating the many different models used within these processes. This project starts with a generic introduction to models and their properties before analysing specific models within the digital factory. A framework for a "Model-Map" is then proposed to illustrate the interrelations between the individual models; as a first step along the road to complete model integration.

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**O'Neill, Andrew**  
**Assessor:** R. Butler  
**Supervisor:** Tim Lummering, ILK, RWTH Aachen, Germany  
**Development of a wing mass estimation programme for preliminary aircraft design**  
The aim of this project was to develop a wing mass estimation software tool for application in preliminary design. The tool was to offer structural considerations as a counterweight to aerodynamic wing optimisation software used at the institution. Two programmes were written, one taking a statistical approach based on modern aircraft, another taking a mathematical one based on wing-loading. Their accuracy was tested both on existing aircraft and novel configurations. The mathematical method was finally selected.

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**Tan Din, Yit**  
**Assessor:** C. J. Brace  
**Supervisor:** Sebastian Hölemann, Institut für Regelungstechnik (IRT) der RWTH Aachen, Germany  
**Development of linear Model Predictive Controller for OXYFuel Process**  
OXYFuel Process has been researched intensively as a zero-emission energy generation method. The complex addition to the OXYFuel power plant of RWTH Aachen for the provision of oxygen calls for a new control strategy. The aim of the project is to develop a linear Model based predictive controller (MPC), which natural ability at controlling complex MIMO Systems and intrinsic ability to provide optimum control while accounting for operation constraints makes it the prior candidate to automate the system.

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**Gennaro, Bianca**  
**Assessor:** A. W. Miles  
**Supervisor:** Isabelle Villemure B.Ing. (Poly), M.Sc.A. (UBC), Ph.D. (Montreal), PostDoc (UofCalgary), Ecole Polytechnique de Montreal affiliated with Research Centre at St Justine Children's Hospital.  
**Experimental Characterisation of Mechanical Properties of Porcine Growth Plates Aged 4, 8 and 18 Weeks.**  
This project aimed to characterise experimentally the mechanical properties of porcine growth plates at four stages of development (newborn, 4, 8, 18 weeks). Distal ulnae of pigs were dissected and growth plate samples obtained for mechanical stress relaxation testing in unconfined/confined compression. Valid data from unconfined compression tests was run through an optimisation programme, based on a predefined model, to extract intrinsic mechanical properties. Results were analysed comparatively for the different stages of development.

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**French**

**Burke, Richard**  
**Assessor:** S. A. Akehust  
**Supervisor:** Dr Xavier Tazia, InstEquipe Énergétique des Moteurs à Combustion Interne, Ecole Centrale Nantes, France  
**Intake Water Injection as a NOx Reduction Technique for Automotive Diesel Engines**  
Automotive Diesel engine emissions regulations will become more stringent over the coming years and new technologies will need to be developed to meet them. Water injection is a technique that promises to rise to the challenge, offering an improved compromise on emissions species. Experimentally based research on an HSDI Diesel engine has been used to quantify improvements due to intake water injection and a phenomenological study has begun to explain the in cylinder events.

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**Cherel, Audrey**  
**Assessor:** M. J. Carley  
**Supervisor:** Roger Barènes, ISAE (Campus SUP AERO), Toulouse, France  
**Experimental Analysis of Ducted, Variable Pitch Contra-Rotating Propellers!**  
Contra-Rotating propeller systems are increasingly becoming a popular propulsion method for micro-aerial vehicles. The angle of attack of the blades is an important consideration when optimising the rotors. The aim of this study is to determine, using experimental techniques, the optimum configuration of the rotors, as well to explore their performance at different blade angles. The result was an increase in the efficiency of the next generation of MAVs, at minimum added cost.

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**Khan, Irshad**  
**Assessor:** S. J. Culley  
**Supervisor:** Prof. Ricardo Camarero, Ecole Polytechnique de Montréal, Canada  
**Project: The management of digital sketches through PLM solutions**  
Product Lifecycle Management (PLM) solutions are a powerful information management tool to be used during the Product Development Process. However, one of the areas that has not been dealt with extensively is the integration of sketches, created during product creation and development, into the electronic Bill of Materials (eBOM). This study aims to examine the possibility of doing so by:
- reviewing existing digital sketching and sketch-to-CAD technologies  
- developing a classification to be applied to digital sketches  
- devising a methodology to enable the integration of these digital sketches into a PLM system.
### Prizes 2007

#### Smallpeice Trust Prizes - Design

**Group Design Prize:**  
Mechanical/Manufacturing/IED/Automotive

**Formula Student Design**

<table>
<thead>
<tr>
<th>Mohammad Abdul Aziz</th>
<th>Dominic Afonso</th>
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<tbody>
<tr>
<td>Jason Bleach</td>
<td>Oliver Carledge</td>
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<tr>
<td>Philip Cash</td>
<td>Chi Sing Cheug</td>
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<tr>
<td>Stuart Chubbuck</td>
<td>Benjamin Drum</td>
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<td>David Given</td>
<td>Eric Griffiths</td>
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<td>Philipp Gschwantner</td>
<td>Paul Kleister</td>
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<td>Peter Morton</td>
<td>Mark O’Sullivan</td>
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<td>Joseph Pepper</td>
<td>Ian Siddy</td>
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<td>Stephen Sollars</td>
<td>Mohammad Abdul Aziz</td>
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<tr>
<td>Alex Paine</td>
<td>Andy Witherspoon</td>
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**Group Design Prize: - Aeronautical**

**Aerospace Team D (CAELUS AEROSPACExE)**

<table>
<thead>
<tr>
<th>Donald Browing (Project Manager)</th>
<th>Huw Brassington</th>
<th>Anna Davis</th>
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<tbody>
<tr>
<td>Moshab Ghazzawi</td>
<td>Christopher Imrie</td>
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<tr>
<td>Jack Nicol</td>
<td>Ioannis Panagiotou</td>
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<td>Kabir Singh</td>
<td>Matthew Thompson</td>
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<td>Chee Yap</td>
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**Accenture Business Prize**

**Business Prize**  
Sustainable Energy System

<table>
<thead>
<tr>
<th>Helen Alderson</th>
<th>David Grice</th>
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<tr>
<td>Simon Hall</td>
<td>James Middleton</td>
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<tr>
<td>Nathan Waters</td>
<td>Hayley Weston</td>
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**Department of Mechanical Engineering Prizes**

**DOWTY GROUP NO 1 PRIZE**  
Best student graduating in Mechanical Engineering

<table>
<thead>
<tr>
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**ROYAL AERONAUTICAL SOCIETY PRIZE**  
Best student graduating in Aerospace Engineering

<table>
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<tr>
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**FORD MOTOR COMPANY PRIZE**  
Best student graduating in Automotive Engineering

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**IET PRIZE**  
Best student graduating in Manufacturing Engineering

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**CROWN Europe PRIZE**  
Best student graduating in Innovation & Engineering Design

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**FRANK WALLACE PRIZE**  
Best performance in the Language option of Engineering with a language course

<table>
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<tr>
<th>Alison Royle</th>
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**JOSEPH BLACK PRIZE**  
Best performance in Group Business & Design Project 2005/6

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<tr>
<th>Timothy (Tim) Morgan</th>
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**IMechE (HEADQUARTERS) PRIZE**  
Project Prize (Research Project)

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<tr>
<th>Laurence Batley</th>
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**IMechE (WESTERN BRANCH) PRIZE**  
Fredric Barnes Waldron Best Student Prize

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**HMGCC Best Specialist Design Project**  
Highest level of academic ability in Year 3 2005/6

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<tr>
<th>Jennifer Ridley</th>
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**ROLLS ROYCE PRIZE**  
Outstanding academic performance in the final year (SMMG)

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<tr>
<th>Adrian Vaughan</th>
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**THORNTON**

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<th>Philip Aslett</th>
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**ARMOURERS & BRASIERS PRIZE**  
Medal for outstanding project work (SMMG)

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**ELI LILLY Best Year 2 Performance**

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<th>Ronald Ching Long Lam</th>
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**QINETIQ**  
Best Final Year Project displaying Integrated Mechanical/Electrical Engineering

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<tr>
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**RENCOL Best 1st Year Student 2006/7**

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<th>James Wonnacott</th>
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**SCHLUMBERGER**

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**Joh Barr Memorial Scholarship for Best 2nd Year student 2006/7**

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**BUGATTI Best Formula Student Input from 3rd Year student 2006/7**

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<tr>
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**WILLIAM SIEMENS MEDAL**  
Best Industrial Placement Performance combined 2005/6

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**with Other Achievements**

<table>
<thead>
<tr>
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