



**Department of
Mechanical Engineering**

Joseph Black Lecture
Given on the occasion of the opening
of the Design and Project Exhibition

June 2005



Balancing Conflicting Needs by Design

given by

Geoff E Kirk RDI CEng FRAeS FIMechE

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1974 – 2005

<p>1974 <i>Design as a Team Game</i> E. McEwan Vice-Chairman, Engineering Joseph Lucas Ltd</p>	<p>1982 <i>The Context of Design</i> Sir Kenneth Corfield Chairman and Chief Executive, Standard Telephones and Cables Ltd</p>	<p>1989 <i>Industry: Design and Young People</i> Ivor Owen The Design Council</p>	<p>1998 <i>Technological Innovation A managed resource</i> Professor Chris Pearce Inbis Group plc</p>
<p>1975 Ralph Shire Memorial Lecture: <i>Some Detail Design Problems in Aircraft Gas Turbines</i> L. Haworth FRS Director Rolls-Royce Ltd</p>	<p>1983 <i>Higher Innovation: The Management of Creative Disorder</i> Sir Basil Blackwell FEng Vice-Chairman and Chief Executive, Westland plc</p>	<p>1990 <i>Effective Management of Design</i> Peter Hills SERC Engineering Design Coordinator, The Design Council</p>	<p>1999 <i>The Creation of the Gos Challenger</i> Adrian Thompson Paragon Mann Ltd</p>
<p>1976 <i>Innovation in Engineering Design</i> Dr A. Moulton CBE. Director, Moulton Developments Ltd</p>	<p>1984 <i>Designing for Dependability in Advanced Power Plant & Associated Systems</i> Dr W. Rizk CBE FEng FIMechE Chairman, GEC Diesels Ltd and GEC-Ruston Gas Turbines Ltd</p>	<p>1991 <i>Competing with Better Products in Less Time</i> Keith Nichols UK Marketing Manager, (CIM) Digital Equipment Ltd</p>	<p>2000 <i>The Birth of a Morgan Innovation and Tradition Create a New Sports Car</i> Charles Morgan Joint Managing Director Morgan Motor Company Ltd</p>
<p>1977 <i>Ship Design</i> R.J. Daniel OBE Director General of Ships and Head of Royal Corps of Naval Constructors</p>	<p>1985 <i>Better Design for British Industry</i> Sir William Barlow FEng Chairman and Chief Executive, BICC, and Chairman, The Design Council</p>	<p>1992 <i>Concorde and its Successor</i> Sidney Swadling Director of Engineering, British Aerospace Airbus Ltd</p>	<p>2001 <i>The Farnborough F1 Air Taxi A Revolution in Air Travel</i> Richard Noble OBE, Director Farnborough Aircraft</p>
<p>1978 <i>The Designer's Craft</i> Dr G.B.R. Feilden CBE Director, General British Standards Institution</p>	<p>1986 <i>The Car of the Year 2000</i> A.C. Rudd BSc(Eng) FSAE Managing Director, Lotus Engineering Ltd</p>	<p>1993 <i>Metrology in the Field of Engineering</i> David McMurty Chairman and Chief Executive, Renishaw plc</p>	<p>2002 <i>Designing the Human Knee</i> Professor John O'Connor Oxford Orthopaedic Engineering Centre, University of Oxford</p>
<p>1979 <i>Design for Maintenance in British Rail</i> K. Taylor Chief Mechanical & Electrical Engineer, British Railways Board</p>	<p>1987 <i>Design for Living</i> Sir Montague Finniston FEng FRS</p>	<p>1994 <i>Tribology in Machine Design</i> Professor Duncan Dowson CBE FRS FEng</p>	<p>2003 <i>Challenging the Design Process Models</i> Prof Mogens Myrup Andreassen Technical University of Denmark</p>
<p>1980 <i>Effective Industrial Innovation and its Contribution to Britain's Economic Recovery</i> V.J. Osola Redman Heenan International</p>	<p>1988 <i>Design: the Common Goal</i> John Butcher MP Parliamentary Under Secretary of State Department of Trade and Industry</p>	<p>1995 <i>Design to Thrive</i> Professor Ivan Yates CBE FEng</p>	<p>2004 <i>Information and Knowledge Management in an International Design Firm</i> Mike Shears CBE FREng Chairman of Trustees, Arup Group</p>
<p>1981 <i>Investment in New Product Development</i> Viscount Caldecot DSC FEng Chairman, Delta Group plc</p>		<p>1996 <i>Innovation-Led Competitiveness through Equivalence in Product, Organisation, Technology and Culture (EPOC).</i> Professor Gordon Edge</p>	<p>2005 <i>Balancing Conflicting Needs by Design</i> Geoff E Kirk RDI CEng FRAeS FIMechE Chief Design Engineer - Civil Aerospace. Rolls-Royce plc</p>
		<p>1997 <i>Engineering & Design Against the Odds</i> Mr James Dyson, Chairman Dyson Appliances</p>	

Foreword

Welcome to the 2005 Design and Project Exhibition and the Joseph Black Lecture given by Geoff Kirk, Chief Design Engineer - Civil Aerospace, Rolls-Royce plc.

This booklet contains details of the 11 Group Design and Business projects and 3 Aerospace projects undertaken by 3rd year students, and the 116 engineering projects and 19 language projects undertaken by 4th year students. This year we have 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. A large number of these projects are undertaken in conjunction with industry to which we record our thanks, but we are very happy to further discuss proposals from potential collaborators across the disciplines. Details of all projects and the previous 6 keynote addresses are included on the Departments website at www.bath.ac.uk/mech-eng/design-exhibition. What has become apparent in recent years, or perhaps has become more apparent is the range of considerations that a modern engineer has to consider. In particular the economic and environmental or legislative drivers that manifest themselves. Thus, as the title strongly implies it is a Group Design and Business project, which means that each team has to produce a business plan to assess the marketability and viability of the activity that they are involved with. This year we have been able to enhance this dimension of the activity with additional input via the Higher Education Innovation Fund (HEIF) and also the Design Council. This has been via the appointment of an Enterprise Officer and the introduction of some design/business development master classes. This has been in conjunction with our University's Research and Innovation Services operation. (www.bath.ac.uk/researchandinnovation/index.html).

It is thus particularly appropriate that we have Geoff Kirk, Chief Design Engineer - Civil Aerospace, Rolls-Royce to deliver the 2005 Joseph Black Lecture - "Balancing Conflicting Needs by Design". To see the challenges in terms of pressures, velocities and temperatures that Geoff is referring to, the Rolls Royce website has its award winning 'Journey through a jet Engine' at <http://www.rolls-royce.com/education/schools/journey02/flash.html>. Geoff has had a long and distinguished career with Rolls-Royce with a particular emphasis on design. His work in the area has been recognized by the award of the Royal Aeronautical Society (RAeS) Bronze Medal, The Prince Philip Designers Prize and most recently by his appointment to be a council member of the Design Council.

SJCulley
On behalf of the design team

2005 Joseph Black Lecture

Balancing Conflicting Needs by Design

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Chief Design Engineer-Civil Aerospace



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1. Introduction

The days when designers were concerned, if ever they were, with solely technical challenges are certainly gone. Increasingly there is the need for better products services, lower life cycle costs, faster time to market, disposal and sustainable production, the design task has become more interdisciplinary.

This paper describes some of the issues facing a designer, particularly in the aerospace industry, and by some examples illustrates some recent issues and how they were resolved.

2. Requirements

Every product has a customer or a user. Customers are varied; they may be an individual, an organisation or a socio-economic group. Needs may be clearly defined and be very specific or be quite loosely expressed aspirations. There may be a number of different customers for a single product.

Requirements are defined in terms of the product's attributes, its function, mass, unit cost etc. They are conditional statements about attribute quantities and are often expressed as inequalities, for example the performance of the product must be at least a certain value while the cost may not exceed another.

There are occasions when attributes can be traded, if one attribute over achieves then another may be allowed to deviate from the initial requirement within a limiting value.

Value is lost if a statement of requirements is presented unilaterally without discussion there can be many subtleties that are lost in translation. It is important that the designer is intimately involved in the interpretation of the customer's needs and the eventual capture of the requirements.

For air transport, in particular, there are many customers, or parties with an interest in the design of the aeroplane and engines. Figure 1 shows the customers for an aero engine. These can be grouped into major interest groups, the passenger, the airline, the airframer, the environment and the engine manufacturer's employees and shareholders.

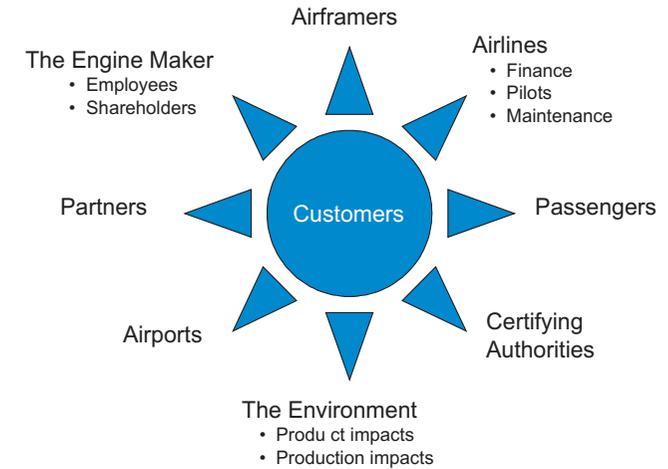


Figure 1- The Customers

3. Air Transport

Air transport has increased significantly over the last 20 to 30 years, on average about 5% per annum. It forms a global network linking people, countries and cultures. Over 1.6 billion passengers fly for business and leisure. Air transport is particularly vital for business, creating jobs by opening new market opportunities. Products and services are moved quickly over long distances and over 40% of world trade of goods (by value) is carried by air. Air transport provides 28 million direct, indirect and induced jobs worldwide

The Passenger

Passengers require convenience, comfort, punctuality and low cost, safety is taken for granted. There is a significant potential for growth in passenger air travel as shown by comparing the relationship between gross GDP and the number of passenger trips taken, figure 2. There are a number of countries with large populations such as India and China whose GDP is set to grow in future and whose trips per capita are significantly lower than most western countries. It is predicted that the growth of traffic will continue at the same 5% rate for the foreseeable future.

Growth will be by both flying hub-to-hub, consolidation, and point to point, fragmentation. This requires two types of aircraft: a long-range large capacity aeroplane and a smaller one, still capable of long range, but with the flexibility to operate economically over short and medium ranges.

The Airline

An airline generates a financial return from passengers and freight and its profitability derives directly from the difference between its cost and its revenues, the yield. A business trades heavily upon the confidence of its customer and the global events of the past few years, such as SARS, international conflicts, and maligned actions, have shaken the confidence of the travelling public. In addition the recent dramatic increase in fuel cost has added to their difficulties. So despite the continuing growth of passenger and freight traffic, airline profitability has been hugely variable.

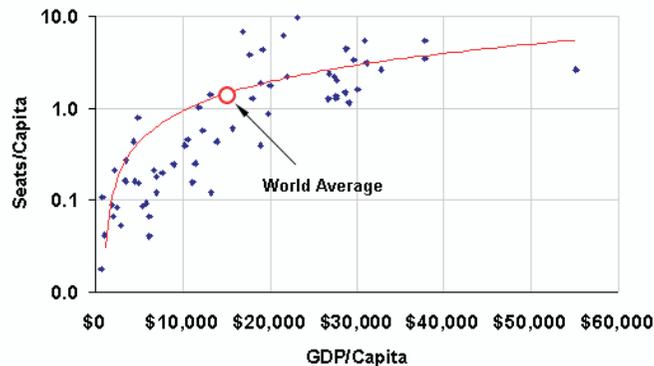


Figure 2 - The Potential for Growth

The airline industry has made structural changes and increased the number of passengers flying on each aircraft, even so airline's yields have decreased.

This volatility and lack of stability for the airline world imposes design requirements that will allow the customer to be protected as much as possible from the changes within their business and their global environment

The Airframer

When designing a new aircraft, the Airframer requires efficient engines that address all their customers' needs both initially and over the projected life of the aircraft - a timescale that can be 50 years.

There are the obvious attributes that determine the aircraft's capability to perform the required mission such as thrust levels, fuel consumption and elements relating to the physical installation of the engine onto the aircraft such as weight, size, systems and interfaces. The engines must also meet all the regulatory rules. But today, an airframer's requirements extend much further, encompassing a view upon the total cost of operation of the aircraft over its projected life.

Thus, the mission must be achieved at an economical rate, measured by the Total Aeroplane Revenue and Operating Cost (TAROC) of the aeroplane expressed as the cost per flying hour or cost per trip. There are a number of engine related factors that contribute to TAROC, acquisition cost, fuel burn, noise, emissions and maintenance costs. The airframer will also be concerned about the engine's impact upon the residual value of the aircraft should a customer choose to sell it.

The Environment

The growth of air transport has increased pressure on the environment. There are a number of factors manufacturing processes, operational issues, maintenance and the end of life disposal.

The major one, the operational issues, can be broken down into two parts: Global - the climate change that is dominated by fuel use and Local - the local air quality, nitrous oxide and particulates and noise. The concerns are expressed differently in different parts of the world; in Europe, global and local concerns dominate whereas in North America the concerns are predominately local. In the rest of the world the environment is generally not a key issue apart from a few exceptions, notably Japan.

The aerospace industry has been addressing these issues for a number of years with significant reductions in emissions and noise. However the projected increase in air travel means that the efforts to improve must also be increased. The senior executives of the major aerospace companies in Europe, the Advisory Council for Aeronautics Research in Europe (ACARE) have committed their respective companies to specific environmental targets that address quality, affordability, the environment, safety, the efficiency of air transport and security.

The Engine Manufacturer

The investment required for a new engine although not the same as the aeroplane is still extremely large. The shareholders of the company require a return on their investment. The employees of the company also have a stake in the success of the product.

4. The Aerospace Response

Despite all the challenges, companies are still willing to invest large sums of money to produce new aircraft. In the large aeroplane market both Airbus, with the A380 and Boeing with the 787 Dreamliner have embarked on significant new programmes designed to address the major needs. Both the aircraft presented significant challenges for the designer.

The A380 is aimed at high-density traffic, 550 passengers serving the major airport hubs. This is the largest passenger aeroplane in the world. The engines needed to be capable of generating 80,000lbf thrust and be very efficient but quieter and with lower emissions than current comparable aircraft.



Airbus A380 Maiden Flight

The 787 Dreamliner was designed to be a complete family offering a short-range operation and two long-range versions of 223 or 260 passengers. This required an engine capable of operating equally efficiently in the thrust range of 53,000 lb to 70,000 lb to satisfy both the short-range and long-range requirements. A great deal of emphasis was also placed on the aircraft environmental impact to be clean and quiet.



Boeing 787 Dreamliner

The 787 Dreamliner was launched after all the concerns relating to air travel had manifested themselves so the conflicts for the designer became even more pronounced.

During the design phase there were two prime examples that illustrates where the designer reconciled conflicting requirements.

5. The Engine Response

The Trent 1000 Fan

A factor that dominates the engine architecture is the choice of fan and its diameter once this has been set it is extremely difficult to change and seals the engine characteristics for the remainder of its life. The fan diameters of large civil transports have increased over the years to increase propulsion efficiency to reduce fuel burn. This has the benefit of also reducing jet velocities and hence noise.



Trent 1000 Engine

However increasing the fan diameter also increases weight and aerodynamic drag to the point where the improvement in propulsion efficiency is negated and fuel burn increases, figure 3 shows this trend. Increased levels of technology can obviously improve the absolute levels but the basic conflict remains.

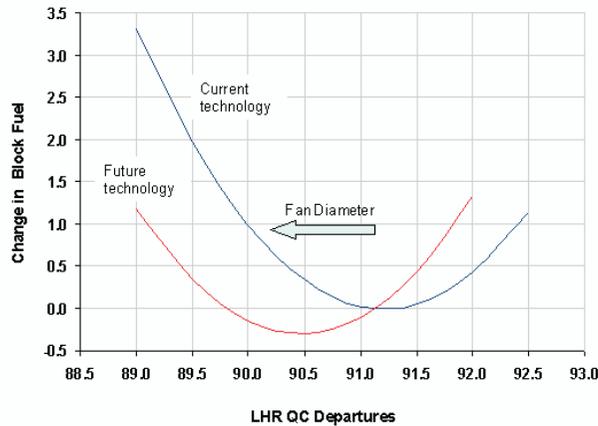


Figure 3 - Optimising Noise and Fuel Burn

This may appear to be a conflict between the environmental and operational requirements, noise versus lower fuel costs. But increasing fuel burn increases the emission of CO₂, so there is an additional conflict between two environmental issues, local airport requirements and global issues. The understanding of this issue comes about because of the designer's concern to optimise the design.

Trent engines have three spools, the Low (LP) Intermediate (IP) and High Pressure (HP). A low hub tip ratio fan in the LP system, where the hub radius is reduced, gives more airflow for the same fan diameter. This leads to lower weight, lower drag and hence lower fuel burn but the capability of the fan to increase pressure at the root is reduced. The overall pressure ratio can be maintained by increasing the combined pressure ratio of the other two systems. The enabling technology was to be able to raise this pressure ratio in the same number of stages with no loss of efficiency.

With the new architecture it was then possible, by careful optimisation of the by-pass flow and the fan tip pressure ratio, to optimise the fuel burn loop shape as shown in figure 4. The majority of fuel used in a long-range mission is during cruise whereas in the short-range mission the majority of fuel is used in climb and descent, so the requirements of both the long range and short-range aeroplanes could be addressed.

Recognising the potential of the revised fan configuration and putting in place the technology acquisition to enable it to be incorporated achieved this.

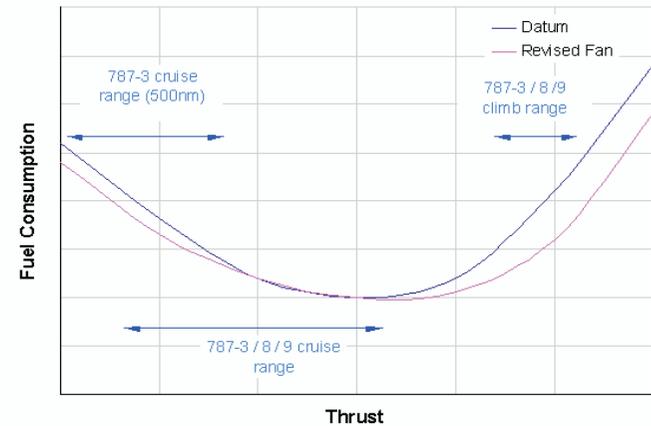


Figure 4 - Optimising Fuel Burn

The Trent 1000 Power Off-take System

The engine is the principal source of power for an aircraft. In addition to the prime function of providing thrust the engine also provides secondary power, electricity, hydraulic power and air for cabin pressurisation.

Conventionally, mechanical power is taken directly from the High Pressure (HP) System by a mechanical drive to an Accessory Gearbox (AGB) on the outside of the engine. This gearbox drives the electrical generators and hydraulic pumps needed to supply the aircraft and the oil and fuel pumps needed by the engine itself. Pressurised air is ducted from the core compressors at the appropriate pressure, cooled and introduced into the passenger cabin. The more air that is extracted the more aerodynamically stable the compressors become. The engine is started by rotating the HP system through the radial drive from an air turbine starter mounted on the AGB.

It has been recognised that there could be significant advantages by having a single energy source resulting in a simplified energy management system, the obvious one being electricity.

The 787 Dreamliner is a More Electric Aircraft (MEA). The implications for the engine are that the pneumatic systems are deleted for both cabin pressurisation and starting. Large starter /generators, again, mounted on the AGB, are powered from the engine and provide the starting capability.

An option would be to retain the current arrangement, drive the gearbox from the HP system and use the drive in reverse for starting. Extracting power in this manner means that the HP compressor is unable to sustain the pressure ratio required as the power requirements increase and is driven towards aerodynamic instability. To maintain stability margins the size of the engine core would need to increase but this reduces the engine efficiency and increases the fuel burn.

There existed conflicting requirements, the airframer's desire for simplified systems and the need for improved fuel consumption.

MEA had been the subject of an integrated study with the airframer over a long period of time, where various options for power extraction had been studied. As a result it was shown that taking power from the IP system where, although the IP compressor's ability to generate pressure ratio is reduced, it is restored by the HP compressor which moves along its normal working line and the IP moves into a more stable region.

This had a number of other significant benefits as in descent there was no requirement for handling bleed valves on the IP compressor and the descent idle power could be reduced. This resulted in up to 50% of the descent fuel burn is saved giving a 6% efficient fuel burn improvement relative to a conventional off take engine on the short range mission. To put this into context 1% of specific fuel consumption is worth about 1.2% emission fuel burn and the trends are for 1% improvement in specific fuel consumption per annum so this one change represents something like four years development of engine efficiency.

The issue of engine starting remained to be solved, as rotating the HP system is the only viable method, this was done using a fluid coupling, similar to a motorcar automatic transmission to engage the HP system during start and disengage for normal running.

There were other benefits that were not originally envisioned, the engine has enhanced starting capability and lower noise. Because the idle thrust was lower there was a reduction in aircraft brake wear.

This was a classic example of an indeterminate design task where the requirements and solution co-evolved and there was no clear process to a solution. This could only be achieved by close and open working with the airframer over a number of years and jointly defining the requirements.

Both the above examples built upon the architecture and heritage of previous products. The added value was to be able to exploit this and build upon it.

6. Summary and Conclusions

It is the designer's tasks to fully understand the customers, their needs, reconcile the conflicts and formulate a statement of requirements and not accept the requirements without question. They need to be aware issues outside the purely technical arena.

The designer generates the information, is aware of the consequences of design decisions and should make those responsible for framing legislation and setting policy aware of those issues.

The designer needs to take the initiative in formulating capability strategies.

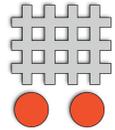
Clearly the challenges for the aerospace industry of customer expectations performance, cost, delivery and environmental requirements are varied, challenging and in many cases conflicting but are typical of many industries subject to the same pressures and drivers.

Above all designers need to be creative, eloquent and forceful in bringing new ideas to fruition.

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MEng Group Business and Design Projects

1 Airport Trolley “The Airporter”



Design Brief

Clares MHE are a British company that designs and manufactures supermarket and airport trolleys. Clares currently have the British Airport Authority contract, with lucrative airports such as Heathrow and Gatwick, and there is thought to be considerable potential for growth in Clares' international airport trolley business. The market can be very competitive and product cost is a major concern.

Project Aim

Clares MHE wish to increase their share in the airport trolley market. In order to do this, they must present their trolley and service offering in a sales pitch. Our aim is to win sales pitches with our new product proposal.

Specification/Key Issues

A number of key points were raised by Clares MHE and other sources:

- The trolley must comply with Clares current manufacturing policies
- A flat pack trolley to allow a tighter packing density when shipping complete products or parts overseas
- The trolley must incorporate “Deadman Brakes” a safety feature expected on trolleys by the airports

Achievements/Description of the Design

The design and strategy suggested offers a number of innovative features to add value to both Clares and their customers.

Fully Adjustable and Customisable Trolley: a study of an airport can be carried out to find information for trolley integration (e.g. corridor widths). The trolley can be tailored to this information and the airport's preferences

Airside Trolley Offering: a very small trolley can be produced for Airside (Departures Lounge/Duty Free). This will help the airport to produce extra revenue in its shopping facilities

Flat Pack: the trolley can be completely knocked down and supplied with different packaging options. It will then be assembled near the destination airport

Improved Maintainability: all parts are modular and can be easily replaced on site. This is coupled with a maintenance check up every 6 months

Potential for Future Upgrades or Modules: The modular design allows for future designs to be added. Features such as RFID tags and LCD screens can be implemented

Push Pull Brake Controls: in order to improve the intuitiveness of the Deadman Brakes, a new mechanism has been designed to eliminate problems identified by airports

Designers: O E I Banks, E Elias, A J Bull, A K Bullock, J James, K Hammoudeh

Supervisors: Dr E A Dekoninck, R D Jardine

Sponsors: Clares Merchandising Handling Equipment (MHE) Ltd

2 - Islet Cell Cooling System

Design Brief

A relatively new technique for combating diabetes has been developed using islet cells taken from a donor pancreas. In order for the isolation of the cells from the pancreas to be successful, the process has to be carried out at approximately 4C whilst in a clean room. Our brief from Southmead Hospital in Bristol is to develop a system of cooling that can be applied to the current method of isolation, which allows the process to be undertaken in a clean room where there are strict cleanliness controls.

Specification/Key Issues

The isolation already has a standard procedure, which is currently being undertaken purely for research purposes. A make shift system of cooling has been employed to this procedure, which is suitable for the current laboratory environment but will not pass the guidelines governing the clean room which the isolation is being moved into. There are three key areas for which the current systems of cooling do not meet the clean room regulations, these have been labelled as: Cooling after heating, Agitation and cooling, and Centrifuge cooling.

The main limiting factor of all the designs, are that the clean room which the systems have to operate in, have a strict limit on the amount of particles that can be present in the air that is circulated through it. This becomes a particular issue as even water droplets are classed as particles, so strict control over condensation has been required. All equipment that operates in the room also has to undergo regular and thorough cleaning.

Achievements/Description of the Design

Solutions for the three key areas have been developed, as well as a system for centrally controlling the cooling and storing some of the other apparatus used in the isolation. Designs have been produced that will allow the systems to be manufactured and the isolation to successfully be moved into the clean room facility which has been recently built.

Designers: O M Butcher, A R Featherstone, D T W Chan,
N Delavouet, P J Gallagher, S D Smith

Supervisors: Dr J Darling, Dr D G Tilley

Sponsors: Southmead Hospital, Bristol

3 - Pharmaceutical Manufacturing Project

Design Brief

To design a system to package a new drug under a nitrogen blanket.

Specification

Product X is a product in tablet form
The product reacts to an air/oxygen atmosphere
The product cannot be exposed to the open environment
Product X must be packed under a nitrogen blanket
The product is to be packed on a thermoformer
The equipment is to be situated in a room with operators present
Product X is to be packed into blisters with aluminium base and lidding foil
Each blister is to contain seven tablets
The thermoformer is to produce 100 blisters per minute

Key Issues

Supply of tablets to the line from a bulk container
Operability
Machine access
Handling of rejected product
Changeovers
Cleaning

Achievements/Description of the Design

The design comprises of an enclosure around the existing machine, surrounding the sections where the tablets would be exposed to atmosphere. The enclosure is divided into sections independently supplied with nitrogen, and sealable from each other, so that when faults occur, specific sections can be isolated, and product contamination can be minimised.

Designers: J B Patel, W Chu, A P S Collett, M L Corris,
J S Cox, N J M Crawford

Supervisors: Dr L B Newnes, Dr G Mullineux

Sponsors: Eli Lilly

4 - LoBUS Hybrid Easy Access Urban Bus

Design Brief

Design a hybrid bus for use in urban areas. The bus must have a low-floor throughout its length, be free of steps and wheel intrusions.

Specification/Key Issues

Very compact rear suspension is needed to reduce wheel intrusion into passenger compartment.

Bus is designed as two modules:

- 2m Driver/Power module located at the front of the bus
- 10.5m Passenger module

Hybrid electric propulsion system

Crush Capacity:

- 41 Seated
- 40 Standing
- 2 Wheelchairs

For use in Europe

Achievements/Description of the Design

The bus satisfies the specification criteria, although the floor level had to be increased to 350mm to allow for the rear suspension components. A kneeling suspension was incorporated into the design to lower the floor level to the required 300mm for boarding/disembarking. Air brakes were used on the front axle and hydraulic brakes at the 12" rear wheels via an air/hydraulic actuator. The driver position is centrally mounted and raised above the engine components. This has major manufacturing benefits when considering left/right hand drive versions.

Designers: F Flight, N R Hughes, C L Chan, A D Moorhouse, M Tschirk, J A Wilson

Supervisors: Mr C A McMahon, Dr M J Darlington

Sponsors: Eric Woodcock, Lo-Bus



5 - Integrated energy system

Design Brief

Design a carbon neutral system of energy production for the parish of Chew Magna fitting in with the aims and objectives of the Chew Magna Zero Waste initiative.

Design how the Mill in Chew Magna will be used as a focal point for the Chew Magna Zero Waste initiative.

Specification/Key Issues

The approximate average electricity consumption of Chew Magna is 1.5MW. The design considered the advantages and disadvantages of large and small scale energy production methods for various types of renewable technologies.

Feasibility of energy sources was based on community opinions, economic viability, environmental and infrastructural impact, power capability and cost. Following the feasibility study, the detailed design of selected feasible energy production methods was completed.

Achievements/Description of the Design

It was found that wind energy and hydroelectric turbines were the most feasible way of providing Chew Magna's electricity requirements.

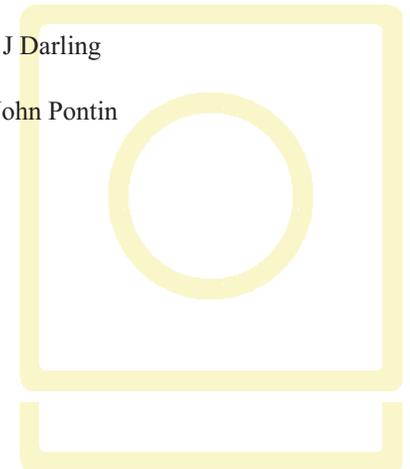
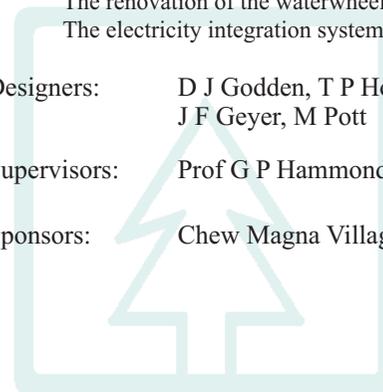
The detailed design of the following was completed:

- Hydroelectric turbine on the weir outside the Mill
- A heat pump system at the Mill
- The renovation of the waterwheel at the Mill to produce electricity
- The electricity integration system at the Mill

Designers: D J Godden, T P Holsgrove, L A S Martel, S Y Gan, J F Geyer, M Pott

Supervisors: Prof G P Hammond, Dr J Darling

Sponsors: Chew Magna Village - John Pontin



6 - Multifunctional Hospital Bed

Design Brief

With the increasing age of the population the number of hip and knee replacements performed annually is increasing rapidly. The design brief is to combine the functionality of a hospital bed with that of an orthopaedic chair, specifically in order to aid patient recovery immediately following a knee or hip replacement. This ultimately will lead to a reduction in inpatient time following such procedures.

Specification/Key Issues

- Perform fully functioning roles as both a bed and an orthopaedic chair
- Create a comfortable environment for the patient
- Provide a safe mechanism of movement for patients
- Create a psychological feeling of being mobile
- Reduce nurse workload
- Meet all current and future regulations

Achievements/Description of the Design

The multifunctional hospital bed is a system that incorporates all of the standard features expected on a modern hospital bed and the following additional systems:

- Folding mattress which creates a comfortable chair
- Separate chair module and base station module; all actuation for the movement of the bed is housed within the base station
- The bed and base station split creating a lightweight chair on wheels which can be patient or nurse controlled
- Automatic docking system at the push of a button
- Clear and intuitive controls

Designers: C J Holden, P F Giddings, B D Weekes, P Hooper,
R J Howell, S R Hood, G J A Hamilton-Fletcher.

Supervisors: Prof A W Miles, Dr D Sirkett

Sponsors: Dr I Heyligers, Dr B Grimm
Atrium Medisch Centrum (Netherlands)



7 - Zero Energy Basestation

Design Brief

A significant cost in the network deployment of basestations is the routing of a power supply to the site.

The requirement is for a renewable power system to be designed for a micro basestation, with all the power generation units and ancillary equipment to be integrated within the basestation infrastructure.

Micro basestations act as an 'underlay' for the macro network. They are of an output size typically used to provide shopping centres or major roads with a mobile phone signal.

Specification/Key Issues

- Generate 340W of continuous power
- Global deployment (UK as worst case scenario for weather)
- Meet environmental conditions ETS 300 019-2-4
- Budget of £15,000 for the product and full installation
- Solution to support the 2004 groups micro basestation
- Design for remote locations

Achievements/Description of the Design

A fully integrated 3890W rated wind/solar hybrid system which generates over 400kWh of power in the UK climate and can be deployed in even the most remote locations. For a cost of £13,000 the product offers the customer a neat and attractive solution, is fully self-sufficient and will allow mobile phone operators to increase their network coverage to areas previously financially and physically inaccessible. The product not only powers basestations but can be used for homes, off-shore platforms and water pumps.

Designers: J M Low, J D Loudoun, D T E Kenning, O U Ogali,
M A A Alias

Supervisors: Dr S A MacGregor, J Cunningham, R G Outram

Sponsors: Motorola



MOTOROLA

8 - Investigation to evaluate the most efficient form of human propulsion for a wheelchair

Design Brief

There is considered to be a need for a wheelchair that is comfortable for regular use, lightweight and highly manoeuvrable. The key feature for the successful creation of such a design is thought to be that of providing a manual drive system that requires the minimum of effort and is convenient to use when negotiating confined spaces, as are found in the home.

Investigate the various human propulsion systems used (or could be used) for propelling a wheelchair and investigate their effectiveness. Compare with the capabilities and strengths of typical users and create an outline design scheme that either modifies an existing chair or provide a concept that is incorporated into a new design of chair.

Specification/Key Issues

The main requirements of the wheelchair are:

- Comfort
- Safety
- Maximum mobility
- Minimum effort
- Maximum personal function
- Discrete design



Achievements/Description of the Design

The final solution is a wheelchair propelled using a mechanism similar to that found upon a rowing machine. The design is aimed towards users with C5/6 tetraplegia who only have limited use of their upper arms and are unable to propel a traditional wheelchair comfortably. Propulsion is through flexion of the elbow whilst pulling on a cord and braking is achieved by an inward movement of the arm, to squeeze a lever located by the elbow. The combination of these motions allows the user to propel themselves at speeds equal to that of a more able wheelchair user and lead an active lifestyle, where previously they may have been confined to an electric wheelchair.

Designers: D M Phasey, J C Fowler, B M Walker, B J Thomstad,
D A Hammond C A Nearchou

Supervisors: Prof A J Medland, Dr R Mitchell, Dr R Orpwood

Sponsors: BIME/University of Canterbury (New Zealand)

9 - ULTra Charging Project



Design Brief

Our sponsor company Advanced Transport Systems (ATS Ltd) is designing a new and innovative form of public transport, the ULTra Personal Rapid Transport (PRT) system. ULTra will run entirely on battery power and is designed to be self-sufficient. Our brief was to design an automated charging system, along with a levelling and weighing system for the ULTra vehicles.

Specification/Key Issues

Charging: The vehicle needs to be charged at a fast/opportunity charge whilst at the passenger stations, of 1-2C. Additionally, a slow charge of 5-10A should occur whilst at the depot. The system must offer an automated electrical connection between the vehicle and station, minimising human intervention. The possibility of on-board energy storage is to be considered.

Levelling: The vehicle should remain stable and at a constant level whilst at the passenger stations.

Weighing: The payload should be measured whilst passengers embark/disembark from the vehicle, to ensure maximum payload is not exceeded.

Achievements/Description of the Design

The project resulted in two main designs; one encompassing the charging/power system and the other, the levelling of the vehicle.

Charging

The charging system will operate both at the stations and depot. The system works by an actuator, mounted underneath the station, extending out and making a connection with the vehicle. Once in place the electrical supply is switched on and the battery is charged. As well as charging the battery the electrical supply also charges a bank of ultra-capacitors, which will aid the battery by powering the vehicle during initial acceleration. The charger has the capability to charge the batteries at both a high and low amp rating.

Levelling

The levelling of the vehicle is achieved through the use of an air spring suspension system. This necessitated a redesign of the current suspension used on the ULTra prototype and included a control system to regulate the stability of the vehicle. This system also has the ability to make an accurate readout of the payload, so negating the need for a separate weighing system.

Designers: N G Burree, D C Y Liow, C T Palmer, A J Royle,
M D Snell, A A Young

Supervisors: Dr D N Johnston, Dr P S Keogh

Sponsors: ATS Ltd

10 - Autonomous Underwater Vehicle

Design Brief

To design an autonomous underwater vehicle (AUV) for entry into the AUVSI and ONR's 9th Annual International AUV Competition at San Diego in 2006. The competition consists of six underwater tasks to be executed in as quick a time as possible. Bonus points are awarded for various factors of performance and technical design. As yet no team has entered the competition from outside North America.

Specification/Key Issues

The vessel must have a maximum weight of 63.5kg and dimensions no greater than 1.83 x 0.91 x 0.91m for competition entry

It must be completely autonomous

The vessel sensory payload must have the ability to detect a visual light beacon, a pipeline and box, and an acoustic beacon

All tasks must be completed within 15 minutes

The project is entirely self-funded, so any funding must come from sponsorship, either financial or in-kind

Achievements/Description of the Design

The design concept is a combination of several specialised sub-systems. All sensory payloads are modular, allowing for ease of location and increased flexibility.

Four thrusters were chosen to provide both propulsion and buoyancy control. A small power-pc manages the sensory system and controls the thrusters accordingly. The sensory system consists of two underwater cameras, four hydrophones, three depth sounders and a digital compass.

All components have been selected on a cost effective basis, without compromising the performance objectives of the mission. As a result, a sound base has been developed for future student groups to use as a springboard for further AUV design.

Designers: G S Waterhouse, A L Coxon, T J Ward, T J Rosenberger,
R Sellen, R W Saunders

Supervisors: Dr W M Megill, Mr S J Culley



11 - Formula Student - Team Bath Racing



Design Brief

To design a small single seat racing car, adhering to the FSAE rules. The car will compete in the International 2006 Formula Student Competition. The newly formed Team Bath Racing will be the University of Bath's sixth entry into the competition.

Specification/Key Issues

The formula rules are clearly defined which provide the basis for a fundamental specification. The key restrictions are summarised below:

The car must be open-wheeled with an open-cockpit

The car must be powered by a four-stroke engine of no greater than 610cc

The maximum cost of the car must not exceed \$25,000

The car must accommodate the 5th to 95th percentile American male

The noise produced must be below 110dB

In order to achieve superior competition performance, the car must deliver excellent handling, braking, acceleration and reliability.

Achievements/Description of the Design

Team Bath Racing has achieved an all new design philosophy of producing an extremely lightweight, manoeuvrable and drivable vehicle. The key features of the design include carbon fibre sandwich monocoque at the front locating the driver and other subsystems. The rear entails a steel space frame to allow easy access and exchange of engine.

The engine used will be a Yamaha WR450F with an optimised intake and exhaust producing torque exceeding 50Nm over a broad rev range. This is transmitted to the asphalt through a fully optimised semi-automatic transmission allowing gear changes in a tenth of a second.

To complement the powertrain, a front and rear push rod actuated suspension system is employed. Double unequal length outward diverging wishbones are used at the front and rear of the car. Rack and pinion steering with 100% Ackermann geometry is used in conjunction with 10" lightweight alloy wheels. On this model four independent brakes are employed to stop the car.

Dynamic analysis showed that the design should make use of the optimum wheelbase of 1625mm and a wheel track of 1125mm. As a consequence of Team Bath Racing's strict design philosophy, the projected mass is 170kg (excluding driver and liquids) which is the lightest by a substantial margin in the history the University of Bath's Racing Cars.

Team Bath Racing will also be developing the current 2005 car to enter into the Class 1 (200) series of the competition. The car will make use of a turbo charged Yamaha R6 engine driving through a continuously variable transmission. To reduce the weight of the car a structurally stressed engine will be installed.

Designers: D Tavares Alves, J J H Berote, O G M Carless,
D W Goose, N J Erhardt, J G Hair, M L Hellebrand,
S J Hunt, S R Kallu, M A Knowles, A J Patterson,
B W Plocki, N R Sandwith, A P C Winsor
C Yim, G Woods

Supervisors: Dr G W Owen, Dr K Robinson, Dr C J Brace, A Green,
Prof J G Hawley, Prof D A Parker

Sponsors: Castrol, Royal Navy, Perkins Engines Co Ltd, Nitron,



Aero A - 150 Seat Regional Turbo-Prop



Design Brief

With growing concern over the environmental impact of the aviation industry and the inevitable implementation of tax on aircraft emissions there is an ever growing need for a reduced fuel burning aircraft. A regional turbo-prop with a two class passenger capacity of 150 seats is to be designed.

Aims

The aim is to design an aircraft that meets the technical specification while assessing the profitability in the market. The business case aims to estimate project costing, reduce operating costs and determine the market into which this aircraft will be launched.

Specification/Key Issues

- Minimise fuel burn and operating costs
- Cruise between Mach 0.68 - 0.82
- Operating range of 3500nm (150 passengers)
- Take off and landing field length below 2400m and 1600m respectfully
- Comply with current EASA-25 aircraft regulations

Achievements/Description of the Design

The design of a conventional layout aircraft has been completed by the ten member team. The aircraft is capable of carrying 150 passengers 3500nm in a two class layout and 186 passengers >2400nm in a high density single class layout. The cruise Mach number for the aircraft is 0.75, based upon a compromise between fuel burn and operating costs. With a MTOW of ~66 tonnes the aircraft is capable of carrying 14.25 tonnes of payload the full 3500nm range. The use of modern materials has also been considered and this is seen by the use of composites in the wing structure and empanage.

Designers: D Clark, D King, G Cranston, T Bell, T Alyalu,
D Wang, S Gibson, M Burrows, P Murphy, I Idrees

Supervisors: Dr R Butler, Dr M Wilson, Dr G D Lock, Dr H A Kim,
(University of Bath) Dr M Carley, Prof I Gursul, Prof G W Hunt,
Dr C W Stammers, Dr M A Sokola, Dr D GTilley

Supervisors: Prof J Jupp, Mr A Williams, Mr M L Jukes, Mr M Ball,
(Industry) Mr R Holliday, Mr C Stevens, Sir Robert Hill,
Mr C Dressel, Dr J Crocker, Mr K Macgregor,
Mr P A Chapman, Mr D Usoro, Mr R Davies,
Mr R G Outram,

Technical Support: Airbus, Rolls-Royce, Dowty Propellers, Smiths Aerospace

Aero B - 150 Seat Regional Turbo-Prop: Enviroprop



Design Brief

In the context of the growing concerns over environmental issues a specification was set for an aircraft with reduced impact on the environment. The development of the high-power, high speed turbo-prop engines for the Airbus A400M may yield a possible solution to the reduction of fuel burn, albeit at slower cruise speeds compared to modern turbo-fan propelled aircraft.

The purpose of the study was to design a turbo-prop driven short-haul aircraft to meet regional airliner's requirements, whilst assessing the feasibility of such an aircraft by producing a business case.

Specification/Key Issues

The aircraft must transport 150 passengers in a two class layout a distance of 3500nm and 180 passengers in a single class high capacity layout a typical mission distance of 500nm. It must be a turbo-prop propelled aircraft capable of cruising between M0.68 and M0.82 with a maximum operating altitude of 41,000ft. The key driver of the design was the reduction of direct operating costs taking into account a predicted fuel price of \$2 per gallon at the entry into service date of 2012.

Achievements/Description of the Design

Enviroprop has a low wing and T-tail configuration with two turbo-prop engines. The maximum takeoff weight and operational weight empty of 64 and 34 tonnes respectively reflect the weight saving advantage of an all composite fuselage, wing box and empennage. Its cruise speed of M0.76 ensures that Enviroprop is at parity with the competition whilst reducing fuel burn and subsequent direct operating costs.

Designers: D Worth, P Roberts, L Dunscombe, E Simpson,
N Donaldson, G Lidher, A Ng, M Lema Trillo,
R Gozalbo, B Woolf

Supervisors: Dr R Butler, Dr H A Kim, Dr M Wilson, Dr I Gursal,
(University of Bath) Dr G D Lock, Dr M J Carley, Prof G W Hunt,
Dr C W Stammers, Dr M A Sokola, Dr D G Tilley

Supervisors: Mr M L Jukes, Prof J A Jupp, Mr P A Chapman,
(Industry) Mr A Williams, Mr D Usoro, Mr R Davies, Mr M Ball,
Mr R Holliday, Mr C Stevens, Mr C Dressel,
Dr J Crocker, Mr K Macgregor, Sir Robert Hill,
R G Outram

Technical Support: Airbus UK, Rolls-Royce, Dowty Propellers, Smiths Aerospace

Aero C - 150 Seat Regional Turbo-Prop



Design Brief

With the increased focus on environmental issues there is a drive from within the civil aircraft market to dramatically reduce fuel burn. High-power, high speed turbo-prop engines are currently being developed for the A400M, these technological developments could offer airlines with a significant reduction in fuel burn. The purpose of this project was to design a turbo-prop driven, short-haul aircraft, to meet the airlines' needs. The increased expense of slightly slower cruising speeds, will be off set by the fuel cost savings and Pollution taxes which have been projected. The aircraft is to be operated from small airports and therefore meet the noise and other operational constraints imposed by the relevant regulations.

Aims

The aim is to design an aircraft to the technical brief with the aid of business techniques to try and make the aircraft desirable to the airlines.

Specification/Key Issues

(1) The aircraft must offer 2 layouts, a 150 pax standard 2-class, 180 pax high-density configuration, and be capable of a range of 3500nm with 150 pax + baggage. (2) Its economical cruising speed should be between 0.68-0.82M. (3) Aircraft must meet Stage 3minus 20 ENdB (cumulative) noise limits. (4) Allowances for technology improvements and environmental targets are projected to entry to service date of 2012.

Achievements/Description of the Design

Aircraft MTOW is 69 tonnes providing economical travel for 150 passengers over a maximum range of 3500nm. The aircraft will cruise at Mach 0.75 at an ICA of 31,000ft. The aircraft incorporates a high wing, conventional tail configuration and is powered by two advanced turbo-prop engines. The design utilises carbon fibre wing and fuselage structures reflecting advances in technology by the entry to service date of 2012.

Designers: S Smith, T Hunt, M Burleigh, J Elliott, G Klimaytys,
I Randles, W Renold, S Martin, T Fewster, J Tremain

Supervisors: Dr R Butler, Dr M Wilson, Dr H A Kim, Prof I Gursul,
(University of Bath) Dr G D Lock, Dr M J Carley, Prof G W Hunt,
Dr C W Stammers, Dr M A Sokola, Dr D G Tilley

Supervisors: Prof J Jupp, Mr A D Heaton, Mr A Williams, Mr M Ball,
(Industry) Mr M L Jukes, Sir Robert Hill, Mr R Holliday, Mr R G Outram,
Mr C Stevens, Mr C Dressel, Dr J Crocker, Mr K Macgregor,
Mr P A Chapman, Mr R Davies, Mr D Usoro

Technical Support: Airbus UK, Rolls-Royce, Dowty Propellers,
Smiths Aerospace

Project Sponsorship 2004-2005

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.

Clares Merchandise Handling Equipment (MHE) Ltd
Southmead Hospital, Bristol
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Atrium Medisch Centrum (Netherlands)
Motorola Ltd
Bath Institute of Medical Engineering
University of Canterbury, New Zealand
ATS Ltd
Castrol Consumer
Royal Navy
Perkins Engines Co Ltd
Nitron Racing Systems Ltd
Mocal Oil Control Systems
Ricardo Engineering
IMechE/SAE
Berkeley Stainless
Green Tweed and Co Ltd
Airbus UK
Rolls-Royce plc
Dowty Propellers
Smiths Aerospace

The Smallpeice Trust

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

Integrated Industrial Projects (IIP)

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 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

Student	Company	Supervisor
Pattinson, C	Rolls-Royce	GDL
Johnson, R	Rolls-Royce	GDL
Mezzallo, W	Rolls-Royce	GDL
Peet, S	Rolls-Royce	GDL
Cheng, V	Rolls-Royce	GDL
Child, M	Rolls-Royce	GDL
Fussell, L	Atkins	CAM
Beckett, B	HCL Fasteners	GWO
Williams, S	Reed Hycalog	FAO
Harvey, P	BMT	WMM

France

Student	Company	Assessor
Knoerzer, D	SNR, Annecy	PSK
Kuhr, T	Numeca International, Brussels	MW

*2005 Engineering Projects
Undertaken at the University of Bath*

Student	Title	Group	Supervisor
Abberley, J	Design of a consumer product for campers	DM	GWO
Waking up inside a tent on a sunny summer morning can be uncomfortable, due to the high temperatures which often occur. This product uses solar energy to power a small fan which introduces cooler outside air to the tent interior, reducing the temperature to a more comfortable level.			
Allen, S	Pointing a person-powered punt	MS	PSK/ WMM
The Bath University Racing Submarine Team (BURST) is intending to enter an International time-trial sprint event held in Bethesda, U.S. in June 2007. This project involved the production of a boat that was used as a test bed to illustrate the development of an autonomous control system for future application to the HP submarine.			
Andrews, T F L	Chains that are weaker than their 'weakest link'	SB	GWH
In the 15th Century Leonardo da Vinci performed a series of tension tests, the results of which counter classical engineering theory that the breaking strength of a wire is independent of its length. This project uses bi-stable models to attempt to show such results by including disturbances in the system.			
Anthony, J	Viscoelastic convective flows in porous media	AA	DASR
The onset and development of oscillatory convection of a viscoelastic fluid saturating a horizontal porous layer was investigated. The governing Darcy-Benard equations were modified with stress relaxation and strain retardation parameters. Linear theory and numerical results were compared with those for Newtonian fluids. Applications include geophysical flows, the recovery of crude oil and the modelling of biological fluids.			
Aufranc, D	Thermal performance of hydraulic accumulators	MS	DGT/ RFN
Hydraulic accumulators are devices to store energy in the form of gas under pressure and are widely used in fluid power applications such as vehicle suspension. But during the gas compression and expansion some heat is lost by heat transfer. The aim of this project is to do a model to predict this energy loss and to validate it by experiments.			
Azaime, H S	A finite element model of tissue heating caused by diagnostic ultrasound scan	SB	SEC
A finite element (FE) model has been developed using an FE package called ANSYS to predict skin and tissue surface temperature rise when transducer was in contact with standard tissue phantom. The temperature predictions produced from the model were validated against the experimental data provided by the Medical Physics Department, RUH.			

Student	Title	Group	Supervisor
Bell, M P	Automatic balancing of shafts that rotate both above and below their critical speed	MS	PSK
An investigation is conducted into automatic methods of balancing super-critical rotors, without compounding imbalance at sub-critical speeds. The investigation considers both existing methods and new methods, proposed during the project. The production of a test-piece and super-critical rig, for the assessment of one proposed automatic balancer, is also included.			
Bennett, D W	Autonomous grapnel robot	SB	JFVV
The main aim of the project was to design an autonomous grapnel robot that uses an elastic mechanism to fire a grapnel hook and drag itself as its main form of locomotion.			
Bhudia, N	Effect of a jet on vortex merging	AA	IG
The purpose of this experimental based report is to investigate the effect of a jet on vortex merging at low Reynolds numbers. A pair of co-rotating vortices is formed on actual aircraft during landing configuration. This phenomenon has major impacts with regards to aircraft landing separation distance. Therefore the findings of this report provide a further insight within this field of research.			
Bickerton, J	Bath driving cycle and characteristic vehicle emissions estimation	AA	JGH/SA
Traffic motion within the City of Bath was surveyed with a vehicle and a driving cycle was produced to represent this data using best fits of the acceleration/speed profiles of data sectors between stops. The driving cycle was then tested for repeatability and the emissions compared to a statutory cycle, using the chassis dynamometer at the University of Bath.			
Blanch, R	The Biefeld-Brown effect? Electro-kinetic thrust	AA	SAM
The force on an asymmetric capacitor charged to an extremely high voltage was explored from various theoretical perspectives, although the primary goal was to research ion cloud theory. A finite difference model was built, and thrust seen partly in the expected range, but many results remain inconsistent with reality.			
Boorman, T	Highly manoeuvrable electrically powered wheelchair	MS	CWS
This project concerns the analysis and control of a novel wheelchair being developed at BIME (Bath Institute of Medical Engineering). This will enable users to manoeuvre in restricted spaces or to use the chair for sporting activities.			
Bowley, P	Ctenobot Propulsor	SB	WMM
The Ctenobot is an AUV designed to study kelp beds that uses knife-fish inspired fins for propulsion. This report has modelled the motion of these fins based on a film study of the fish and a computer simulation. It has been found that the fish use a rounded triangular wave for propulsion.			

Student	Title	Group	Supervisor
Brambles, O J	The entrainment of a free convection plume by a neighbouring surface	AA	DASR
An investigation into the effects a nearby surface has on a free convection plume located in a porous material. Numerical methods were used to solve the governing equations. Detailed analysis was performed into how the Rayleigh number and heat source position influence the plume development and entrainment towards the surface.			
Brown, A I	Trends in energy consumption and carbon dioxide emissions associated with UK non-domestic buildings	AA	GPH
This project identifies the past, present and future energy consumption and carbon dioxide emissions attributable to the UK's 2 million non-domestic buildings. Modelling typical buildings and simulating new technologies provides a detailed assessment of future scenarios and building regulation development.			
Burls, A	The effect of span-wise flexibility on thrust performance from flapping wings	AA	MJC/ WMM
An experimental investigation was undertaken using three wings of different span-wise flexibility. The wings were flapped in a water tunnel at varying frequencies and Reynolds numbers. It was found that span-wise flexibility can be beneficial to thrust generation but there is a dependency on wing stiffness and the operating parameters.			
Butler, L A	Incorporating human attributes into manufacturing simulation	DM	ARM
Manufacturing simulation is one of the most commonly used tools to aid the facilities planning process. However as less deterministic elements such as humans are incorporated, problems with the model accuracy arise. This study looks at the possibility of incorporating human attributes in simulation to reduce this inaccuracy and the user's uncertainty.			
Calvert-Brown, A	Review and application of energy absorption/dissipation techniques	DM	FHO
Energy absorption applications range from traditional shock absorbers to train buffers and anti-earthquake mechanisms. This project provides an overview of many different energy absorption techniques and examines, in detail, the construction of base isolation devices that are used in earthquake protection devices. Plastic deformation techniques that have the property of absorbing large energies were proposed as a replacement to current methods.			

Student	Title	Group	Supervisor
Carrington, A W	Analysis and testing of sandwich structures in compression	SB	GWH
Sandwich structures are composite panels consisting strong thin outer faces separated by a thick lightweight core. The project looked to investigate the response of aluminium and expanded polymer foam sandwiches in compression, to identify the possible failure modes and the behaviour of the structures in the build up to failure.			
Clement, P J	Is the internal architecture of bone structurally optimised?	SB	JLC/ HAK
The human desire to maintain activity levels demands the functional maintenance of the skeleton. Consequently a detailed understanding of bone mechanics considering the interrelation between bone formation and environmental conditions is required. This project applies structural optimisation methods using finite element analysis in order to investigate the internal structure of cancellous bone.			
Cooke, A L	Development and implementation of suitable pass/fail criteria for a loose prosthesis as determined by vibration testing	SB	JLC
Vibration testing, based on past research, was carried out on simple models of bone and femoral prosthesis system. Theory suggests that the system will produce differing harmonic responses at various stages of loosening. The test results were then used to set out criteria that can be used to accurately detect loosening by non-invasive means.			
Corrigan, J	Study of air filtration for a cellular basestation application	AA	SAM
An investigation into filter test methods and environmental models to establish an effective filter performance model able to predict filter change frequencies in real operating environments.			
Costa Cunha e Almeida, D	Study into weight management of a Formula Student car	FS	KR
Analysis into the effect of weight and inertias on the performance of a Formula Student car. With the aim to better understand where the weight comes from in these cars and how to best exploit the lack of rules regarding their minimum weight.			
Crichton, C	Pressure transients in pipes	MS	DNJ
This project involves the development of an unsteady friction model for pressure transient under turbulent flow conditions. The frictional model was subsequently incorporated in a computational model for pressure transient using the method of characteristics approach. Experimental analysis was also undertaken to validate this model.			

Student	Title	Group	Supervisor
Crump, S	Variable Valve Timing for a Formula Student Racing Car	FS	KR
This project involves testing of a VVT camshaft phasing device custom made for a Honda CBR motorcycle engine to determine mechanical stability, accuracy of camshaft phasing and performance benefits of such a system. It also involves the preparation of a BURT car to be dynamometer tested with the VVT engine.			
Cubitt, A 	Tennis ball pressure chamber	SDP	ANB
Due to the permeability of rubber, the air within the cores of tennis balls gradually seeps out making them lose their bounce. By storing tennis balls in a pressurised container, this leakage rate can not only be slowed down but reversed, thus restoring the bounce. Experimental procedures were able to provide the proof that was lacking for the efficacy of this technique and emphasis was placed on user-centred design to design the product.			
Dailey, S	Making wood out of sensible materials	DM	AB
The project involves research into using a fibre winding machine to create a material with similar mechanical properties to those seen in wood. Testing of the material will produce results that can be compared to those of natural wood.			
Davies, M L	Technical development / management of a formula student team	FS	GWO
This project is split into four sections; inboard suspension calculations on this year's formula student car, final drive analysis on last year's car, driver assessment and selection for the 2005 formula student competition and project management of the team. The work carried out included the design of adjustable anti-roll bars and selection of a new final drive ratio. Methods for driver selection were proposed and management detailed.			
Deighan, T	Engine performance modelling and valve-train design	FS	JGH
Engine modelling: continued development work of the Yamaha R6 WAVE model for the Formula Student competition, with improved validation against additional test data. Valve-train design: development of valve-train system design and analysis software, to provide an easy to use logical program for the design and analysis of valve-train systems. Including prediction of component stresses, valve jump, spring surge and lubrication limitations.			

Student	Title	Group	Supervisor
Denness, W	Measuring the variance in grip force applied to a tennis racket handle as a consequence of racket-ball interaction during service	SMM	ANB
Lateral epicondylitis may be attributable to reduction in tennis racket control; a consequence of the modern game, and the design of the racket handle relative to the player's hand. Changes in the principal gripping forces applied to a tennis racket as a result of racket-ball interaction during service were measured.			
Dickinson, J P	The suspension crutch	SB	AWM/ HCT
The crutch is an accepted method of enabling a patient with ambulatory problems to regain mobility. However many patients find crutch ambulation both painful and exhausting. The aim of this project is to develop and test a crutch that will enable prolonged, pain free, crutch ambulation.			
Douache, F	Virtual reality simulation	MS	DGT/ DNJ
This project is about exploring the uses of the virtual reality suite in the University of Bath. Two different simulations were prepared; these include an anatomy simulation for a skeleton model and a simulation for a fuel testing rig that will be built in the power transmission lab. Part of the project activity was to prepare a concise marketing plan for the VR suite.			
Drayton, P	Test facility for the evaluation of tendon repair techniques	SB	AWM/ JLC
Tendon repair remains one of the greatest challenges in surgery. While many techniques have been developed, an optimum solution remains elusive and varied methods of experimental comparison make selection difficult. This project follows the development of a methodology and test facility and evaluates their performance against published data.			
Dubois, G	Flexible manufacturing systems and buffer strategies	DM	ARM
A flexible manufacturing system (FMS) is designed to combine high productivity and production flexibility. The first aim of this project is to settle down a methodology for the design and planning of FMS. This project also presents a buffer strategy that can be achieved in order to optimize a production line, overcoming to problems like breakdowns or bottlenecks.			
Eaton, R L	Determining the environmental footprint of Wiltshire & Swindon	AA	GPH
This project aims to determine the environmental footprints for the local areas of Wiltshire and Swindon. The environmental footprint is used to provide an indication of sustainability for a defined population and is based on the consumption of resources. It ultimately measures the pressure of humanity on global ecosystems.			

Student	Title	Group	Supervisor
Ebling, D	Developing a new jointing technique to improve the manufacture of wheelchairs and trikes in developing countries	SDP	EAD
Motivation assists local partner organisations to supply suitable wheelchairs to the huge number of disabled people in the developing world who desperately need them. Current frame fabrication techniques are labour intensive, limiting productivity and quality. This project details the development and testing of alternative fabrication methods for steel tubular frame.			
Farrar, P N	Optimisation of a diesel engine for the Shell Eco-Marathon	MS	JD/KR
The Shell Eco-Marathon is a competition held annually throughout the world where participants aim to achieve the most miles per gallon of fuel. The University of Bath has a long standing pedigree in this competition, and participates in a number of fuel classes. The purpose of this project is to continue the development of the diesel engine in preparation for competition in July.			
Fell, A	Non-linear analysis of frame-works for morphing wings	SB	RB/GWH
Structural morphing, or shape control, of aerodynamic components can potentially offer significant improvements in performance, for example, by altering wing shape to reduce drag during the various stages of cruise. This project seeks to establish capabilities for analytical modelling of novel structures that achieve shape change by actuation from one stable state to another.			
Fenton, C T	Development of a finite element procedure for thermal/structural optimisation of a turbine disc	AA	HAK/MW
Optimisation is the process by which the shape and topology of a structure is modified according to defined design objectives by an algorithm that finds the optimum design solution. By optimizing the turbine disc structure the thermal efficiency and stress efficiency of the structure increases whilst achieving minimum weight.			
Garcia, P	BURT 4 handling analysis to include instrumentation	AA	CJB/JD
The investigation included setting up BURT04 (the University of Bath's 2004 entry to the formula student competition) with various sensors, ready to carry out 4 different tests to produce objective data relating to the vehicle's dynamic behaviour. From this data, and driver perception of the quality of the vehicle's handling performance, an attempt at making links between objective metrics and subjective assessments was made.			

Student	Title	Group	Supervisor
Goodwin, C G	Computational fluid dynamics study of a diffuser ventilation system	AA	MW/DGT
An experimental project was undertaken in 2004 to investigate the airflow through a HVAC diffuser. A large amount of data, both qualitative and quantitative, was produced during the investigation. The aim of this project was to complete a computational fluid dynamics validation of the results obtained.			
Gordon, S D	Ultrasonic evaluation of cartilage	SB	JLC
Cartilage damage is an increasing problem in the western world with a growing number of people suffering from arthritis. All existing methods of assessment either risk causing more damage or are only useful at a late stage, ultrasound offers the possibility of assessing the cartilage state in a rapid, non-invasive fashion.			
Greaves, C C	Near field interaction of a simulated engine jet with wing tip vortices	AA	IG
The study using flow visualisation and flow measurement is to investigate the near field interaction of a simulated engine jet with a wing tip vortex in order to assess the potential for enhanced vortex dissipation, with application to minimizing the vortex hazard around commercial airports.			
Grunfeld, T M	Design of a safety device for horse owners	SDP	GWO
The market research, design and prototyping of a device to aid a "cast" horse when stabled. The project also looks at other problems concerning the lifting of other similar sized, injured or downed animals such as cattle. The device is designed to be applicable to both of the scenarios.			
Gun, W A	Non-linear dynamics in contact conditions	MS	PSK
Investigation of the characteristics of rotor displacement in a rotor auxiliary magnetic bearing (AMB) system at the point of contact with an auxiliary bearing. Simulations were undertaken by using an existing developed model based upon a flexible rotor/magnetic bearing system. Modifications will be made to the model to produce better and more accurate predictions. Simulink software in conjunction with the Matlab programming language will be used to set up or modify the existing model.			
Hackett, J	Innovative pharmaceutical pack providing benefits to consumer and process to manufacture	SDP	GM
Pharmaceutical packaging has changed little in decades. Much is unsuitable for use by the elderly or people with limited dexterity and information provision is basic. This project aims to design a novel pack, providing consumer benefits, after which a machine concept will be designed and animated to show the process.			

Student	Title	Group	Supervisor
Hamilton, M	Airflows through a diffuser for an HVAC application	AA	SAM/ DGT
Displacement ventilation systems utilise the buoyancy of hot air, to provide comfort and ventilation for occupants. Audience Systems offer displacement ventilation for auditoriums via an expensive under seat unit. In this experimental investigation alternative methods of under seat air diffusion were investigated and potential design changes recommended to Audience Systems.			
Harris, C P	Micro air vehicle wing morphing	AA	IG
Investigation into the flight dynamics of span-wise cambered delta wings can determine the aerodynamic advantages and methods of control already seen in bird and insect flight, and with technological advances in adaptive materials and shape memory alloys, morphing wings are set to become a fundamental development for micro air vehicles.			
Harvey, J	Global energy absorption through local compliance control	SB	JFVV
The project is an experimental investigation into the effects of holes in tracing paper on tensile energy absorption. The aim was to discover whether the localised plastic damage caused by holes could be utilised to increase energy absorption. The research has potential applications in energy absorption material technology.			
Hawker, J	Design and finite element analysis of a submarine hull	AA	HAK/ WMM
The project uses finite element analysis to examine and compare methods of reinforcing the composite submarine shell, and concludes a design based on the results.			
Helliwell, J M	Fuselage structural design for next generation aircraft	SB	RB
This project presents a structural concepts study of non-circular pressurised fuselage configurations for blended wing body (BWB) aircraft with an emphasis on an 'open-cabin' structure.			
Hicks, A	Commercialisation of UREAD	DM	FHO
Dr F Osmon (University of Bath) has invented a universal re-usable energy absorption device (UREAD) that offers advantages over traditional devices in a variety of applications. The scope of this project is to devise a commercialisation strategy, identify the most suitable applications and begin the commercialisation process.			
Hopcroft, A	Design optimisation of MCP finger joint prosthesis	SB	AWM/ DMS
The project entailed creating a solid model of an existing design. The design was altered to allow for a more anatomical motion during flexion of the hand. Finite element analysis was used to ensure that the changes decreased the stresses observed during flexion and extension of the joint.			

Student	Title	Group	Supervisor
Hughes, J	RoboMinnow Project - Phase 1	SB	WMM
RoboMinnow project will design and build a prototype miniature AUV that is inspired by the way fish swim and their muscular-skeletal physiology. Phase 1 of the project comprises conceptualisation, design and initial experimentation based on the application of artificial muscle.			
Hunt, A	Formula Student car handling analysis	FS	JD/JLC
In order to establish the handling of the BURT04 Formula Student car the vehicle was instrumented as part of this project. Steady state handling tests were undertaken and the under-steer and over-steer characteristics were measured. The effect on handling of roll-bars front and rear was measured and compared with driver qualitative responses. Following this work it was possible to recommend changes to the suspension set-up that would improve the handling characteristic.			
Isaac, T	Model mark-up in computer aided design	DM	CAM
This project concerns the area of mark-up and 'user interface languages', which were used in the form of application programming interfaces to attach persistent labels to parts of CAD designs. Once marked up, CAD geometries were used for practical applications, such as driving manufacturing analysis and finite element analysis.			
Jackson, O	Rajiform drive	SB	WMM
Design and build of a deformable fin, replicating the pectoral fin of a Stingray. Testing will be performed on the various waves the model will be capable of producing, as an investigation into the incredible propulsive efficiency of fish-like swimming.			
Jaddou, M	Autonomous biomimetic drill	SB	JFVV
Growing interest in extraterrestrial subsurface exploration has prompted an examination of advanced penetration and drilling technologies to sample geophysical data. This report tries to draw inspiration from nature (Sirex Wood Wasp) to design, analyse, develop and produce an autonomous drill probe for use on planetary missions.			
Jeffery, M A	Installation, testing & modelling of a Rotrex SP30-64 supercharger on a Yamaha YZF R6	FS	DNJ/ GWO
The need to increase power output on the engine of the BURT05 race car has lead to the development of a supercharger installation for the vehicle. It is the first time this method has been used so testing and modelling of the engine are required to provide a reliable package that benefits the performance characteristics of the vehicle			

Student	Title	Group	Supervisor
Jervis, R F W	Unsymmetric composite laminates with embedded piezoceramic actuators	SMM	CRB
The focus of the work completed in this project was the possible structural control of unsymmetric laminates, using piezoceramic actuators, for use as a new type of adaptive structure. The specific area of interest being the snap through behaviour observed, between the laminates stable states, which are generated from differences in the materials thermal expansion coefficients during the cure cycle.			
Jones, J L	Rotational reusable energy absorption device investigation	DM	FHO
This project investigates the performance of a reusable energy absorption device designed by Dr. F. Osman, in the University of Bath. The device uses material deformation to absorb energy, caused by extruding a material through a die. The project investigates its performance using different materials in the deformation process.			
Ladd, R	Jumping robots and the Mantis Shrimp click mechanism	SB	JFVV
This project was intended to develop a method of locomotion for a robot to traverse a Martian landscape, looking to nature for inspiration and focusing on elastic mechanisms. Due to the mantis shrimps exceptional performance, the project focus moved to simulating the click mechanism in this animal, a punching strike.			
Laughlin, J D	Adventure racing tent design	SMM	MPA
Design of a new tent to accommodate two persons, with tent mass of less than one kilogram. Novel suggestions made to alleviate problem of condensation and tent mass, whilst retaining adequate shelter from harsh weather conditions. Simplicity deemed to be key but innovative hatch panel used to allow occupants improved levels of comfort and ease of use.			
Lloyd, P	Self excited roll oscillation of delta wings	AA	IG
Self excited roll oscillations or wing rock cause loss of control on highly or moderately swept delta wings. Using round and sharp-edged delta wings, this experimental project studies the variation of primary vortex reattachment, leading edge flow characteristics and the possible effects of sound on leading edge shear layer stability.			
Manning, C	The application of the digging mechanism of the Locust Ovipositor to the design of a deployable biomimetic excavator	SB	JFVV
An investigation of the applicability of the locust ovipositor as a biomimetic design basis for a drill to be used in space exploration, and the feasibility of such a drill. The project involved examination of locust specimens, 2D model testing and numerical analysis on the ovipositor as an excavator.			

Student	Title	Group	Supervisor
Marsh, W G A	Racing sit-ski design/optimisation	SDP	JD
This project aims to improve the performance of a sit-ski currently used by a member of the British Adaptive Ski Team for racing in Paralympic competitions. The suspension mechanism and weight reduction were identified as the key areas for development. A new sit-ski frame and suspension system design has been proposed.			
Mitchell, M	Bioreactor for tissue engineering	SB	SG
Tissue engineering can provide functional tissue grown in vitro. For successful tissue engineering a bioreactor is required to provide a controlled environment, with regards to biochemical, physical and mechanical conditions. The aim of this project was to develop a bioreactor to facilitate the tissue engineering of anterior cruciate ligaments.			
Mohd Yin, M F	Development of semi automated procedure for conversion of CT scan data into a solid model	SB	SEC
To develop a technique for the semi automatic construction of a solid model from CT data. It is intended that the model can be used for finite element analysis. A number of procedures and algorithms are performed using MATLAB image processing toolbox for visualisation and manipulation of the data.			
Monaghan, T	Design and testing of composite primary wing structure: Investigation of stiffener shape and material properties on structural performance under compressive force	SB	RB
Careful manufacture and testing of different composite materials was undertaken to determine their compressive moduli in the 0° and 90° fibre directions. Optimisation & analysis of both orthotropic and laminate stiffened compression panel designs, suitable for use as a primary wing structure, were performed using Viconopt computer program.			
Morot, M	Team work in the design process	DM	LBN
The aim of this study was to identify the parameters that influence design process performance within teams. Therefore, a literature review was undertaken and a framework team-working in the design process based on control theory technique was proposed and evaluated.			
Morris, J	Experimental study of helicopter rotor	AA	HAK/GDL
The development of a model helicopter rotor test rig has enabled the validation of actuator disc and blade element theories by simple experimental means. Characteristics and shortfalls of each approach, particularly with regard to rotor induced velocity, have been investigated in both the hover and descending flight regimes.			

Student	Title	Group	Supervisor
Mouatt, D	Sloshing of fuel in aircraft fuel tanks	MS	DGT/ DNJ
Project concerns creating a CFD (computational fluid dynamics) model of a 2D rectangular slack fuel tank then subjecting it to different modes of motion to encourage sloshing. This model is then validated experimentally using a Perspex tank on a multi-axis simulation table.			
Murley, R A	Developing environmental design guidelines to combat the rebound effect in consumer products	DM	EAD
This report details the development of environmental design guidelines to combat the economic phenomenon known as the 'Rebound effect' within energy intensive consumer products, through the use of case-studies and the application of such guidelines to a contemporary washing machine.			
Newton, D	Dynamic modelling of and experimentation on an industrial robot	MS	MNS
The aim of this project was to create an accurate computational model of a robotic arm. It involved producing a dynamic model of the robot and its motors using Lagrangian theory in a software package called Dysim, and a model of the robots control system produced in Simulink.			
Nichols, S	Leading edge turbine film cooling	AA	GDL
The effect on turbine blade film cooling effectiveness of various parameters in the leading edge region was investigated. Tests were carried out in a low speed wind tunnel using an engine-representative large scale model. This will provide a fuller understanding of the complex fluid dynamics of the region, enabling the design of a more efficient cooling system.			
Okazaki, Y	Mass customisation of food production	DM	GM
The aim of the project is to understand the concept of mass customisation and discuss the feasibility of mass customisation to the conventional food industries.			
O'Mahony, C	Pressure measurement in a high speed motorcycle engine	FS	GWO
Development and analysis of pressure measurement techniques suitable for a Yamaha R6 engine. Aims were to obtain combustion and performance data to validate and improve simulated engine models, and quantify the effect of specific design changes. The sensitivity and accuracy of these techniques were also analysed to determine their suitability.			
O'Shea, W	Woodpecker hammer	SB	JFVV
In nature, woodpeckers are the master chisellers. This project aimed to gain an insight into the reasons behind the success of the woodpecker by trying to understand the kinematics of the drumming cycle. The project identified factors which led to successful drumming and looked at applications which could incorporate methods that the woodpecker employs.			

Student	Title	Group	Supervisor
Ostle, T	Knowledge based engineering (KBE) for change element design	DM	SJC
Testing, validating and developing design for changeover techniques and rules within the University of Bath - My project was to analyse the potential for design for changeover with regard to changeover improvement.			
Palmer, R	Organising electronic files in Engineering organisations	DM	BJH/ MJD
Effectively managing computer files can be difficult for individuals. To address this, a software tool and questionnaire have been developed to investigate the types of computer files used by engineers and establish current practice for their management. From the data obtained, a methodology has been produced to support more efficient electronic file management within engineering organisations.			
Phillips, A J	Rock climbing safety systems	SMM	JV
Rock climbing at a high standard often requires the use of less than adequate safety systems. The reduction in peak force during a fall is identified as a means of improving safety and the study of force characteristics within the rope system is undertaken during simulated climbing falls.			
Pickwell, I	Gas turbine pre-swirl cooling system compressible flow	AA	MW
Pre-swirl cooling systems occur in many rotor-stator systems to transfer cooling air to the rotating blades. This project used a general purpose CFD software package to introduce compressibility effects to a computational model of the system. Comparisons between computations of engine operating and experimental test rig conditions were made.			
Poyntz-Wright, O	Experimental investigation of compressibility effects on a low-sweep delta wing	AA	GDL/IG
An experimental project researching the effects of compressibility on a low sweep delta wing. Flow visualisation and pressure measurements were taken at a range of Mach numbers and angles of attack using the transonic wind tunnel.			
Reed, J A R	Validation of a fully adjustable trailer for the measurement of towed vehicle high speed stability	MS	JD
This study is part of an ongoing programme of research into caravan design. A steel trailer equipped with adjustable masses is used to simulate a range of caravan configurations. Road stability tests are carried out to investigate the level of influence that key design parameters have on the dynamic behaviour of the trailer.			

Student	Title	Group	Supervisor
Reglar, N D W	The design of a fracture healing measurement device	SB	JLC
To produce a concept design of a portable, 'patient-friendly', clinical fracture healing measurement device that utilises the results from the ongoing research into ultrasound and fractures carried out at the University of Bath.			
Reid, D A	Undercarriage for rough landing strips	MS	CWS
Following natural disasters, mercy flights need to land and take off as close to the disaster area as possible. Operation from rough landing strips is a serious concern for humanitarian and military missions This project examines the aircraft design challenges. The intention is to develop a 'smart' undercarriage, for rough terrain operation, and to compare its performance with a passive undercarriage. A Simulink simulation of the ground dynamics of a large transport aircraft has been developed to analyse the problems and inform design of potential solutions.			
Roach, M	Development of the 2005 Formula Student chassis using finite element analysis and validation with physical testing	FS	AG
The chassis for the international 2005 Formula Student event, which helped achieve Overall Class 3 Winner (2004) has been modelled using finite element analysis. This model is validated by means of physical testing, allowing complex loading scenarios to be tested to further the development and performance of the design.			
Rogers, F	Trends in energy use and carbon emissions associated with the UK domestic building sector	AA	GPH
If the UK is to reduce its carbon emissions by 60% by 2050 then the domestic building sector will need to play a large role. It is responsible for around 30% of the total UK energy demand and around 23% of the UK greenhouse gas emissions. In this project the historic trends are analysed in order to determine the key factors that will affect the energy use and carbon emissions in the UK domestic building sector in the future. The technology that could be used to help reduce the carbon emissions from the domestic sector are also looked at. Some future projections are made for a business as usual scenario to help discover the scale of the task of reducing carbon emissions by 60% by 2050. An example of a strategy for the sector that meets this target is given.			

Student	Title	Group	Supervisor
Saunders, R	Developing design guidelines to help entrepreneurs or companies transform bespoke products into products for larger distribution	DM	EAD
The objective of this project was to discover and research methods and trends seen in other companies that have successfully achieved the transformation of a product from low to high distribution, and from this develop ideas for best practice that could be published to enable other companies to do the same.			
Schumacher, D	Analysis of documents/document decomposition strategies	DM	SJC/MJD
The project investigates a new approach to retrieving information from within electronic documents. Document decomposition is a method of fragmenting documents into chunks. By accessing these chunks the document can be explored in different ways. The work investigates and evaluates the application and usefulness of various models called document decomposition schemes.			
Sells, E	Towards a self replicating rapid prototyping machine	DM	AB
Research into, design and manufacture of an automated axis which can create a linear electro-mechanical component. Designed under the self-replication ethos this axis, combined with existing rapid prototyping technology, demonstrates the infant stage of a machine which can make itself.			
Shepherd, R	Web handling for intermittent motion	DM	GM/CJM
When handling webs of materials it is important to maintain an adequate feed supply of material and to keep the tension in the web reasonably constant. A number of ways of doing this are available. One is the use of a swinging arm which rises when material is required thus increasing tension and encouraging the input reel to unwind. This project has investigated modelling the action of such a swinging arm and has generated profiles of the tension against processing time. These are helpful in understanding the processes involved and provide insight into how the handling system should be set up.			
Shield, D	Evaluation of contact stresses in forging	DM	FHO
The aim of this project was to investigate the measurement of contact stress components at the die-workpiece interface during forging operations using pressure pin load cells mounted within the die, with a particular focus on using a combination of normal and angled pins to resolve the friction stress component.			

Student	Title	Group	Supervisor
Shorrocks, R	Impact damage tolerance of composite kayaks	SB	RB
This project concerns the damage incurred as a result of a kayak tackle during a game of canoe polo. Physical testing along with numerical analysis methods are used to examine the impact damage scenario and suggest possible design improvements to either the laminate stacking sequence or material specification.			
Sims Williams, G D	The energy and environmental impact implications of a highly distributed UK electricity system	AA	GPH
The UK electricity system has developed around the basis of large central generating units. Over the coming years, an increase in smaller, distributed generators may provide significant energy and environmental benefits. This paper constructs and evaluates scenarios for the role of distributed generation out to 2050, using interrelated thermodynamic and environmental appraisal techniques.			
Smith, P J	Transient emissions profiling	AA	JGH/CJB
A turbocharged Ford 2.4L, 4-cylinder HSDI (high swirl direct injection) Diesel engine with and without exhaust gas recirculation was investigated for transient gaseous exhaust emissions. Two different speed emissions analysers were compared when undertaking transient changes in torque. Nitrous oxides, hydrocarbons, carbon monoxide and carbon dioxide were examined.			
Soper, N	Biomimetic approach to the design of a climbing Mars Rover	AA	MJC
Analysis of the performance of climbing animals, with emphasis on the slopes and surfaces they can attach to. Application of these principles learned from nature, including relevant scaling laws, to the design of a climbing robot, which will explore the extreme terrains of the Martian surface.			
Spandl, M	GT-Power model of a gasoline direct injection engine	FS	CJB
This research demonstrates the application of 1D compressible flow simulation to a gasoline direct injection engine using the GT-Power modelling package. The wider context of this work was to use this model as part of a software tool to investigate the calibration of Vehicle ECU controller maps.			
Spurr, J	Skeleton Bobsleigh push start force measuring system	SMM	DPA/CC
Skeleton Bobsleigh is a unique ice sport in which athletes must utilise a combination of skills in competition. This project covers the conception, design and development of a push start force measurement system for the skeleton bobsleigh to provide performance data to athlete and coach.			

Student	Title	Group	Supervisor
Steward, T	Design and development of scroll vacuum pump	SDP	SJC
The redesign and development of a highly beneficial component that is unique to BOC Edwards' range of scroll vacuum pumps with the aim of making the pump more compact, visually pleasing and cost effective.			
Teo, C C	Ride and handling investigation	AA	CJB
Investigation of ride and handling affected by anti-roll bars and dampers tuning. Pico player and sensors attached on vehicle is used to measure suspension activity, longitudinal and lateral acceleration, steer angle, brake and throttle pedal position and vehicle speed. The data logging obtained is analysed along a list of answers to questionnaires for each amendment made.			
Thakore, B B	Computational fluid dynamic evaluation of a conceptual yaw-vectoring nozzle for Rolls-Royce	AA	GDL/MW
This study concentrates on applying manoeuvrability enhancement through thrust vectoring to UAV due to their varied application and emerging commercial potential. A computational fluid dynamic investigation is carried out using simplified fixed geometry fluidic yaw vectoring nozzle, provided by Rolls-Royce plc to demonstrate proof-of-concept and preliminary evaluation using CFX 5.7.			
Thethy, S	Carton erection using robotics	DM	LBN/GM
The aim of this research project was to investigate the use of robotic and computer modelling techniques in the carton erection process. The type of carton erection examined involved an epicyclic sun-plant mechanism which pulled skillets from a magazine and rotated them into a fixed back-stop forcing them to open. The project emulated the motion using robotics. It determined the pressure forces on the skillet during motion and experimentally obtained force values during impact with the backstop.			
Tillette de Mautort, A	U-shape equal channel angular extrusion	DM	FHO
Equal channel angular extrusion (ECAE) is used in grain refinement of cast structure of metals and alloys. This project examines the use of a U-shape ECAE device for energy absorption through material deformation and introduces a new design that enables successive re-usability of the device. An upper bound analytical model of the U-shape device was investigated and results were compared with those obtained by the finite element method			
Turner, R	Non-linear modelling of elastomer and hydro-mounts	MS	PP
Elastomer is a complex non-linear material which exhibits both a frequency and amplitude dependence which are typically modelled using a system of springs and dampers combined with a non-linear friction element. Hydro-mounts require further addition to the elastomer model in order to account for the inertia and frictional effects of the fluid.			

Student	Title	Group	Supervisor
Varah, S	Finite element modelling of gas turbine rotor discs	AA	ML/GDL
This project used experimental data obtained from a University test rig to predict the temperature distribution in an engine turbine rotor disc. Simulations conducted in Ansys allowed thermal stress and fatigue life of the turbine disc to be estimated. The simulation results were compared to engine data from Rolls-Royce.			
Warne, A	Small gliders for sensor distribution	AA	MJC
This project is an investigation into the use of small, gliding, delta wing aircraft as a sensor distribution platform. The potential applications and enabling technologies are considered, while the flight dynamics are investigated analytically, experimentally and by simulation.			
Watson, S E	Screw drive for an endoscope	SB	JFVV/ JW
This project looks at the concept of a screw driven, medical, endoscope for operation in the large intestine. Theoretical and experimental results are combined, focusing generating the required driving force for the probe.			
Webb, J R W	Advanced manufacturing techniques in a Formula Student car	FS	AG
An investigation of multi-axis computer numerically controlled (CNC) machining focusing on the benefits over conventional 3-axis CNC machining. This report investigates the potential benefits of multi-axis machining to the Formula Student project. It aims to provide a guide to aid new user uptake of these processes.			
Williams, O	Environmental and sustainability benefit of remanufacturing	DM	CAM/ GPH
This project is looking into the environmental and sustainability benefits of remanufacturing, with a case study in the refrigeration industry. The project looks into the possibilities and barriers to remanufacturing in the refrigeration industry, how recent legislation such as the WEEE directive has affected the industry, and what possible alternative technology could improve the end-of-life options for refrigerators.			
Williams, P G	Modelling variability of chassis dynamometer testing	DM	ARM
This project is an investigation into the various factors which contribute to chassis dynamometer testing variability. This includes the consideration of environmental conditions, driver variability, and control of input parameters. The purpose of this investigation is to improve result consistency in future testing, which will allow more meaningful conclusions to be obtained from such testing			

Student	Title	Group	Supervisor
Wills, M C	Performance and stability in formation flight	AA	MJC
Fixed wing aircraft can benefit from formation flight by utilising the up-wash from the trailing wingtip vortex of the lead aircraft. This reduces the energy necessary to achieve and/or maintain a specific flight goal for the trail aircraft. This project investigates the performance benefits compared to the stability dis-benefits of formation flight.			
Wong, W C K	Unsteady aerodynamics around a flapping wing	AA	MJC
The vortex dominated unsteady aerodynamics around a flapping wing is numerically studied using a time-dependent discrete vortex panel method. Investigations involve modelling a flow over an oscillating 2D aerofoil in pitch, plunge or both. Corresponding wake structures leaving the trailing edge are computed according to the Kutta and Kelvin conditions.			
Wright, D	Human powered submarine: An ergo meter for diver testing and training	MS	CWS/ WMM
An investigation into the efficiency of the human 'engine' in an unusual situation of recumbent stepping in order to facilitate optimum seat design and consequently the most efficient powering of a human powered submarine.			
Wright, J	The application of natural materials for current roles in buildings	DM	AB
The use of ecologically sustainable building materials has the potential to significantly reduce the environmental impact of the construction industry. Hemp-lime concrete is a natural-based material that is ideal for erecting wall structures as it is lightweight, durable and a good thermal insulator. This project investigates ways of improving the physical characteristics and commercial appeal of the material, combining mechanical and chemical testing with product development.			

Key to Groups:

AA = Aero/Auto; DM = Design & Manufacturing; FS = Formula Student; MS = Machine Systems; SB = Structures & Bioengineering; SMM = Sports, Medical & Materials; SDP = Specialist Design Project

*2005 Engineering with Language
MEng Year 4 Project Abroad*

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
FRANCE		
Baxter, F R	The inclusion of physiological properties in a computational model of the human knee <i>Dr L Chèze, Université Claude Bernard (Lyon1) /INRETS, Lyon</i>	AWM
The objective of this study is to make an existing inverse dynamic computational model more representative of the physiology of the knee in order to improve the accuracy of the results it produces. A muscular model is developed to be included in the model's optimisation process.		
Duque, A	Modelling system and planning for the study of the work load of the company "Icare" <i>O Devise, IFMA – LIMOS, Clermont-Ferrand</i>	ARM
To provide Icare (laboratory that does microbiology analysis for other companies) with a software package that performs a simulation of the production workload of the number of orders received built around three big domains: the employees, the rooms, the tests in function of time.		
Fitzsimons, D J	Design and development of an aid for sailors with limited hand strength and functionality <i>D Brissaud, ENSHMG, INPG Grenoble</i>	LBN
Sailing is often promoted as being highly accessible for the disabled. However, for people with limited hand functionality, such as those with arthritis, problems arising from rope-handling can present serious barriers. Solutions for a sailing aid product to overcome these problems have been designed and developed through to prototype stage.		
Garai, C	Study of Corecell foam for the fabrication by infusion of sandwich composites <i>Prof F Trochu, Génie Mécanique, École Polytechnique de Montréal</i>	WMM
The main project aims were to investigate the quantity of resin absorbed by the foam core during an infusion and examine the flexural rigidity of the foam core. Four panels were fabricated using the Vacuum Assisted Resin Infusion process and four-point flexural tests were carried out on sandwich structured specimens and infused foam specimens.		

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
Harvey, A D	Applying an integrated design method to study the consumer perceptions of automobile dash-boards <i>B Yannou, Laboratoire Génie Industriel, Ecole Centrale Paris</i>	EAD
The integrated design method is based on usability tests that apply a combination of classical marketing and decision-making theories to the assessment of product semantics. This project aims to demonstrate the method's application to complicated products; such as the automobile dash-board, and to prove it's relevance in industry.		
McSherry, R	Experimental study of ducted counter-rotating rotors <i>Dr R Barennes, SupAero, Toulouse</i>	SAM
The project was undertaken at the National School of Aeronautics and Aerospace (SUPAERO) in Toulouse, France. It comprised an experimental investigation into the effect of duct geometry on the performance of a ducted coaxial assembly of two counter-rotating rotors, intended for micro air vehicle applications.		
O'Hare, J	Is there a future in the engineering of remanufactured products? <i>D Brissaud, Laboratoire 3S, INPG, Grenoble</i>	CAM
Remanufacturing is a \$53 billion industry in the USA and often has significant environmental benefits over materials recycling and other End-of-Life strategies. This project considers how the Repro 2 design tool can be applied in industry to maximise the benefits of remanufacturing for the customer, the company and the environment.		
Shelswell, R	Validation of an implementation of X-FEM on parallel computers using distributed memory <i>E Béchet, Ecole Centrale, Nantes</i>	GWH
A scalability analysis of the parallelisation of the extended finite element method developed and run on the cluster at the Ecole Centrale de Nantes. Using a 14 processor distributed memory architecture various tests were developed and run to validate the scalability of the code written at ECN.		
van Poelgeest, A	Active control of acoustic vibrations between walls <i>L Gaudiller, INSA Lyon</i>	PSK
The objective of this study was to investigate active control methods and apply them the control of a structural system such as a rotor. A bibliographic study was undertaken in the subject of active acoustic control. The control methods were adapted and simulations were carried out using MATLAB and SIMULINK.		

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
White, B	Evaluation of a capillary tube system 'Aqua 10' for radiant ceiling cooling and heating <i>J Virgone, CETHIL, INSA Lyon</i>	DASR
Heliosaqua are a start up company looking to develop their product, a capillary tube system 'AQUA10', for radiant ceiling cooling and or heating applications. An assessment of the thermal performance of this product combined with different installation materials was carried out for development and marketing purposes.		
Zachariadis, A	Calculs de rotor contrarotatif caréné par une approche Navier-Stokes <i>Dr J Gressier, SupAero, Toulouse</i>	MJC
A computational study aimed at understanding the hovering performance of ducted counter-rotating rotors for micro air vehicle applications. This project looks at the performance of a single rotor, but will be further extended at SUPAERO to consider both rotors. The study includes 3D CAD design, structured mesh generation, CFD calculations and a study of the salient aerodynamical features of the rotor.		

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
GERMANY		
Garlati, T	Analysis of the cost and usability of technologies on the subject of Airport capacity <i>Dipl.-Ing. Björn Brückner, Technische Universität München</i>	MW
This project is part of a larger research project at the TU München, aimed to assess the interdependencies between aircraft and the airport. The aim was to develop a methodology with which the costs incurred with capacity expansions can be better assessed. The focus is on large airport in Europe and in the USA.		
Kandemir, U	Scenario analysis and turbulence management to determine changes required to businesses order processing systems <i>Nils Müller, IWB, Technische Universität München</i>	LBN
Many businesses rely on their OPS to monitor and control all business activities, including supply-chain management, product-shipment and a multitude of shop-floor manufacturing processes. The project details a company-specific method of mapping the future by identifying key turbulences facing a business and consequently deriving required changes in business strategy and on the shop-floor.		
Littler, A B	Creation of a control system to enable calibration of pneumatic probes for automation <i>Prof. Dr. -Ing. R. Niehuis, Institut für Strahlantriebe und Turboarbeitsmaschinen, RWTH Aachen</i>	GDL
The Mach number of the flow within the calibration rig at the Institute für Strahlantriebe und Turboarbeitsmaschinen in Aachen was originally controlled by means of a hand operated valve. In order to enable the entire calibration process to become automated, a new valve was designed. The project aim was to develop a control system to regulate the movement of the valve and to fully implement the new valve into the calibration rig.		

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
McGee, N A	Preliminary in vitro study to compare two lumbar inter-body fusion cages concerning relative motion, stability and subsidence <i>Prof. Dr. H J Wilke, Institut für Unfallchirurgische Forschung und Biomechanik, Universität Ulm</i>	JLC
 Monosegmental spinal specimen with two posterior lumbar inter-body fusion (PLIF) cages	Inter-body fusion cages are most commonly implanted to restore function to spinal segments suffering from degenerative disc disease. Prerequisite for a successful fusion of spinal segments is little relative motion between the implant and vertebra. My objective was to devise a method to measure and calculate the relative motion between an inter-body fusion cage and the underlying vertebral endplate.	
McKenna, R C	Fundamental investigations into boundary layer turbulence with Micro PIV (μPIV) <i>Dr Christian Kähler, Institut für Strömungsmechanik, Technische Universität Braunschweig</i>	GDL
This project employs the novel μ PIV technique to investigate the wall shear stress and velocity distributions in a turbulent boundary layer, with the objective of testing the reliability of existing empirical data. It should provide a valuable reference for the normalisation of these parameters in the inner region near to the wall.		
Rayner, R	The development of a brake control system and tyre slip model for a model of a fuel cell powered vehicle using Matlab/Simulink <i>J Aber, Institut Kraftwesen Aachen, RWTH Aachen</i>	CJB
A Matlab/Simulink model, that simulates the behaviour of the powertrain of a hydrogen fuel cell powered vehicle will be modified. Algorithms to model the influence of tyre slip on the motion of the vehicle will be implemented. The influence of tyre slip and different vehicle configurations on vehicle performance will be investigated.		

<i>Student</i>	<i>Project & Supervisor</i>	<i>Assessor</i>
Stewart, K	Methoden zur parametrierung von einspurmodellen (Methods for the parameterisation of the bicycle model) <i>Prof. Dr.-Ing. F. Küçükay, Institut für Fahrzeugtechnik, Technische Universität Carolo-Wilhelmina zu Braunschweig</i>	JD
Within the field of vehicle dynamic simulation, it was sought to configure a graphical user interface-based system in the MATLAB/Simulink environment whereby a range of bicycle models could, through the use of appropriate optimisation techniques, be parameterised to accurately simulate vehicle manoeuvres corresponding to sets of previously measured vehicle test data.		
Towse, D C	Design of a CAD programme for the construction of a specifications list in general mechanical engineering. <i>Ingo Schulz, IKT, RWTH Aachen</i>	AB
A CAD programme was designed to facilitate the easy construction of an holistic specifications list and table, incorporating various design methodologies, which would also be used to interact with CAD tools for both the earlier and later stages of design.		

Prizes 2004

Smallpeice Trust Prizes - Design

Group Design Prize:

Mechanical/Manufacturing/IED/Automotive

Tetraplegic Standing Device

BENNET, Darren Wai
BOORMAN, Timothy David
COOKE, Anthony Lawrence
AZAIME, Hizam Shah
LADD, Ryan Robert
MARSH, William Geoffrey Arthur

Group Design Prize: - Aeronautical

Military Transport Project: ST4M Centaur TEAM B

BELASSIE, Alexander
CLARKE, Liam Alastair Gordon
GREAVES, Christopher Colin
HAMILTON, Michael Thomas
HARRIS, Christopher
JADDOU, Mustafa
LLOYD, Peter
SHORROCKS, Rob John
VARAH, Sanjeev

Accenture Business Prize

Manufacturing System for Telescopic Seating

HICKS, Alexander Nigel
HOPCROFT, Adam John,
DICKINSON, James Paul,
SELLS, Edward,
JACKSON, Oliver Robert,

Department of Mechanical Engineering

DOWTY GROUP NO 1 PRIZE

KOO, Tony
Best student graduating in Mechanical Engineering

ROYAL AERONAUTICAL SOCIETY PRIZE

MARLES, David
Best student graduating in Aerospace Engineering

FORD MOTOR COMPANY PRIZE

VINCENT, Thomas
Best student graduating in Automotive Engineering

IEE PRIZE

JEZEQUEL, Alex
Best student graduating in Manufacturing Engineering

CROWN Europe PRIZE

BOYD, Malcolm
Best student graduating in Innovation & Engineering Design

FRANK WALLACE PRIZE

NIXON, Mark
Best performance in the Language option of Engineering with a language course

JOSEPH BLACK PRIZE

FAWCUS, Philip
Best performance in Student Group Project

IMechE (HEADQUARTERS) PRIZE

ELLIS, Steven
Project Prize (Research Project)

IMechE (WESTERN BRANCH) PRIZE

ROBERTS, Andrew
Fredric Barnes Waldron Best Student Prize

SIEMENS PLC PRIZE

ZACHARIADIS, Alexios
Sir William Siemens Medal - best student in Engineering with German