MACROBERT AWARD 2006

The Royal Academy of Engineering MacRobert Award is the UK's premier prize for engineering. It is awarded annually for an outstanding innovation, of benefit to the community, which has also achieved commercial success. It seeks to demonstrate the importance of engineering, and the role of engineers and scientists in contributing to national prosperity and international prestige.

Described at its launch as "the Nobel Prize for engineering" the Award was originally founded by the MacRobert Trust and first presented in 1969. Every submission is reviewed by a panel of judges drawn from the Academy's Fellowship and from all areas of engineering. The Award honours the winning company with a gold medal and the team members with a prize of £50,000. Here, we showcase the four finalists for 2006 starting with this year's winner, announced by the Academy's Royal Fellow, HRH The Duke of Kent, at the Awards Dinner on 5 June. Last year's winner is featured on page 20.

ULTRA-WIDE RETINAL IMAGING

OPTOS PLC MACROBERT AWARD 2006 WINNER

Optos was founded and incorporated in 1992 by Douglas Anderson after his, then five year old, son went blind in one eye. A retinal detachment had been detected too late in spite of regular eye examinations. Anderson then set out to commercialise a patient-friendly, non-invasive retinal image product that produced a unique digital ultra wide-field image of the retina in a single capture.

Many indicators of both eye and systemic disease are first exhibited in the retina. These include age-related macular degeneration, diabetes, glaucoma, hypertension and certain cancers. Retinal imaging is therefore an important tool for screening and diagnosis as early detection can save sight and sometimes lives. Routine retinal examination methods provide only a limited, narrow-field view of the retina, typically less than 5% in a single capture, and can often miss the indications of these diseases. Typically, to capture a greater percentage of the retina using traditional methods, the patient's eye must be dilated and multiple images of the retina must be taken.

INNOVATIVE ENGINEERING

Optos' platform technology is its Panoramic200 Scanning Laser Ophthalmoscope device (P200). Unlike traditional or routine ways of looking at the retina, the P200 device provides a high resolution ultra wide-field digital image – branded **opto**map® – of approximately 80% of the retina from a single capture. Image capture time is a mere quarter of a second.

Optos' patented scanning laser system creates a 'virtual scanning point' inside the patient's eye. Two independent low-powered laser sources are combined into a single beam that is projected onto the patient's retina and manipulated through a 200 degree scan angle. Light reflected from the retina is then returned through the scanning system and converted to electrical impulses by highly sensitive photo-diodes. These impulses are in turn digitised and formatted to create the **opto**map® retinal image.

Optos' latest retinal imaging device – the P200MA – provides practitioners with the ability to perform an angiographic medical procedure. P200MA devices are in clinical trials that will develop improved patient treatment methods. Optos' technology provides an unequalled combination of wide-field retinal imaging, speed and convenience for both the practitioner and patient. Its retinal image offers practitioners added diagnostic capabilities, increased medical understanding and enhanced clinical value – and through this higher standard of care can save sight and save lives.

LEADERSHIP IN CUSTOMER SERVICE

The scanning laser system is managed by Optos' suite of proprietary software to support each practice. 'Capture Software' enables operation of the P200, including the facilitation of patient imaging. 'Review Software' allows for the **opto**map® retinal image to be extensively reviewed, manipulated, measured and annotated by the practitioner – the image can therefore be permanently recorded and documented, assisting disease monitoring and improving patient education. 'Reporting Software' provides the practitioner with information on how well the P200 device is being utilised, and Optos with real-time performance information. Optos provides its practitioner customers with ongoing clinical, educational, marketing and technical resources and assistance.

COMMERCIAL SUCCESS

Optos is now a leading medical technology company for the design, development, manufacturing and marketing of retinal imaging devices. Over 2,000 P200 devices are currently installed in professional eye and healthcare practices in Optos' markets – currently the UK, Germany, USA and Canada.

Over 7 million **opto**map® retinal examinations have been performed to date. Expansion plans into Spain and France are underway. Optos reported operating profit of $2 million on revenues of $48.4 million for the year ended 30 September 2005, and floated on the Main Market of the London Stock Exchange in February 2006.

For more information see **www.optos.com**

Optos' P200 device © Optos plc

A380 INTEGRATED WING DESIGN
AIRBUS UK LTD

Today's commercial jets are a result of more than 50 years' optimisation of essentially the same concept, so significant improvements are hard to realise. So when, in the early 1990s, major world airlines identified the need for an aircraft significantly larger, quieter, with more range and up to 20% improvement in operating costs in comparison to the then largest aircraft, the venerable Boeing 747, the design challenges for what was to become the Airbus A380 were immediately obvious.

INNOVATIVE ENGINEERING

Wing design is the key element in meeting the performance and economic targets for an aircraft whilst ensuring long term viability by allowing future developments over a typical timescale of 50 years – a challenge successfully met by Britain for all Airbus wing designs since the very first.

For the A380 wing all aspects of the design were challenged and improved. New aerodynamic methods were developed and employed. New structural optimisation techniques and design principles were used, and in virtually every area of the wing new materials were used, including improved metallic materials and the first use of composite primary structures in a wingbox.

Patented load reduction techniques were developed whereby the fuel mass is actively used to control the load distribution on the wing in all phases of flight – continuing a tradition started in the UK with the Concorde. Manufacturing techniques were also improved, not only to optimise the build process, but patented machining processes were also introduced to save weight.

Implementation of advances in individual disciplines, including the integration of these using Knowledge Based Engineering (KBE) techniques, ensured a more robust design and permitted substantially more design iterations to be studied within a given timeframe.

BENEFIT TO THE COMMUNITY

Airbus is recognised by the UK Government as a valuable contributor to the economy. Its two UK sites have a workforce of around 13,000 and, together with the wider supply chain of some 400 British companies, A380 wing work alone generates jobs for some 22,000 people in Britain.

With Airbus already contributing over £1 billion per annum to the UK trade balance, this is set to rise to more than £1.5 billion with the A380. Prime Minister Tony Blair said: "Airbus yields benefits and dividends that go far wider than simply our ability to produce a great aircraft – the spin-offs in terms of technology, in terms of skills, in terms of our understanding of scientific processes are huge".

COMMERCIAL SUCCESS

Today, the A380 is approximately halfway through its flight test programme and already has firm orders for 159 aircraft (plus options) from 16 of the world's major airlines; an unprecedented level of orders at this stage and a significant success for an aircraft with a catalogue value of around $250 million.

The market forecast, including freighters, is for 1,500 aircraft of this size needed over the next 20 years. This represents only 9% of the market over 100 seats in terms of units, but over 20% or $340 billion in terms of value – an unmissable opportunity for Airbus. The second variant of the family, the A380-800F freighter has already been launched at this early stage.

For more information see www.airbus.com

The Airbus A380

PIPELINE LEAK-SEALING TECHNOLOGY
BRINKER TECHNOLOGY

Brinker Technology have designed and developed an innovative technology for sealing and locating leaks in fluid carrying pipelines. Traditional pipeline leak-sealing techniques are based around external procedures such as wrapping or applying a clamp. For offshore applications this requires divers or the use of expensive deep sea vehicles for implementation, and relies on direct access to the leak site, which in some cases is impossible. Brinker's Platelet Technology™ is an internal leak-sealing technique which can be implemented remotely, eliminating the complexities involved with locating and accessing the leak, and ensuring the health and safety of those involved in the repair.

INNOVATIVE TECHNOLOGY

Platelet Technology™ offers a unique integrity solution to the pipeline industry worldwide. The technique takes a radically different approach to conventional methods in that it seals and locates leaks in a single integrated process. Discrete particles, termed Platelets™, are introduced into a pipeline and carried downstream due to the flow in the line. When they reach the region of modified flow around a leak site, fluid forces entrain them into the leak and hold them against the pipe wall thus providing a seal. The location of the leak can then be determined by surveying the line, because each individual Platelet™ is embedded with a remote tagging device.

This technology is adapted from the human body's own leak-sealing mechanism, whereby platelets which are constantly patrolling the body's veins become activated when they encounter a cut or wound. Although the concept is elegant in its simplicity, it took an extensive development process of Computational Fluid Dynamics modelling in conjunction with Finite Element Analysis, and over five years of physical testing to arrive at a solution ready for implementation in the field.

COMMERCIAL SUCCESS

The first commercial implementation of Platelet Technology™ was in September 2004, on a subsea water injection pipeline on one of BP's North Sea installations. The complexity of the leak location made it unfavourable for sealing by traditional, external methods such as clamping. Brinker Technology were called in to implement a solution which would provide a seal until a planned shutdown in the spring of 2005, six to nine months later.

The Platelet™ deployment was a compete success, the leak having been sealed within 24 hours from the start of the offshore operation. Although originally intended for a service life of six to nine months, BP relied upon the Platelet™ seal for a period in excess of 16 months.

APPLICATIONS

The range of applications for Platelet Technology™ is increasing all the time. A current development project has successfully proven the technology in gas pipelines at low pressure. High pressure tests are planned for summer 2006. Sealing leaks in thermoplastic and flexible flowlines are also key projects on the horizon. In addition, the technology is currently being trialled in the UK water industry where high leakage rates are proving problematic following an unseasonably dry winter.

For more information see www.brinker-technology.com

Nick Ryan, Iain Chirnside and Terry Stebbings of Brinker Technology at their Aberdeen workshop with equipment used to conduct high pressure tests on Platelet™ seals © Brinker Technology

ECO-FRIENDLY ETHYL ACETATE PRODUCTION

DAVY PROCESS TECHNOLOGY

In 1996 Davy Process Technology research chemists suggested the possibility of manufacturing ethyl acetate, an important industrial solvent, directly from fermentation ethanol. The laboratory results demonstrated an economically feasible route for manufacturing ethyl acetate as a industrial solvent that would incur minimal environmental impact. The process was installed in a specially constructed Mini-Plant where it was continuously operated for many months. The Mini-Plant was used to develop a complete mathematical model of the process and yielded engineering data for the design of a commercial plant.

CHEMICAL ENGINEERING CHALLENGES

Most novel chemical processes present chemical engineering challenges. Solving these problems requires a combination of fundamental chemical engineering research and application of state-of-the-art software tools for steady state and dynamic simulation of the process. Ethanol dehydrogenation to ethyl acetate is a sequential reaction and a kinetic model was used to develop a suitable reactor system.

Small quantities of impurities are made on the dehydrogenation catalyst, and a novel solution was to reverse the previous reaction to selectively hydrogenate them to their equivalent alcohols. This considerably simplified separations and an experimental programme was initiated to study pressure drop, liquid hold-up and wetting characteristics of this catalyst at the chosen flow conditions.

The separation of ethyl acetate product from unreacted ethanol by-products and water is complicated by the formation of an azeotrope that prevents further separation of the components. The composition of the azeotrope varies significantly with pressure and so a pressure swing distillation scheme was adopted. A programme of vapour-liquid equilibrium data measurement with extensive process optimisation resulted in the development of a minimum energy consuming system.

ENVIRONMENTAL ASPECTS

Consumption of ethyl acetate as an industrial solvent has increased in recent years but conventional production routes rely on the use of non-renewable natural gas or ethylene. In addition these routes require several steps; they are also not atom efficient.

The benefits of the dehydrogenation process is that it relies only upon ethanol, the majority of which is produced by fermentation. Fermentation ethanol is derived from biomass and, ultimately, atmospheric carbon dioxide. After use as an industrial solvent, ethyl acetate evaporates into the atmosphere where it degrades to carbon dioxide and water. Consequently, this sustainable process route entails no net carbon dioxide contribution.

Mini-Plant for the development of the ethyl acetate production process © Davy Process Technology

COMMERCIAL SUCCESS

This process is of considerable interest in developing countries where there is a shortage of oil and gas. In less than ten years Davy Process Technology has demonstrated to industry that it is possible to develop and commercialise a sustainable process for a commodity chemical. Already, 15% of global production capacity for ethyl acetate has been licensed in a 100% export business with major growth potential.

The technology is now being installed in two plants in China of 50,000 and 100,000 tonnes/year capacities. The plants are nearing completion and will soon go on-stream using bio-ethanol as the sustainable feedstock.

For more information see
www.davyprotech.com