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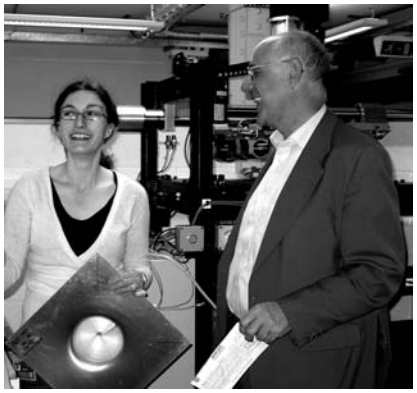
Newsletter



Professor Keith Glover, Head of Department with photography competition winner Kathryn Jackson

UNIVERSITY OF CAMBRIDGE
Department of Engineering

In this issue...

Executive Introduction

Since the launch of the Department's strategy, we have made good progress with its implementation.

The clear decision to develop the Department on two sites, Trumpington Street and West Cambridge, has enabled the Department to take a stronger position when competing for funding. The construction of the new CAPE building is well underway with the move of most of the Electrical Engineering Division scheduled for early 2006. The vacation of their Trumpington Street space gives the Department an opportunity for a significant rationalisation of this site to accommodate new teams, bring together related research and create new space.

The University is now supporting over GBP3.5 million of Higher Education Funding Council for England (HEFCE) bids for refurbishing teaching and research space at Trumpington Street. There is also very strong support for the Institute of Manufacturing's move from Mill Lane to a new building on the West Cambridge Site. These projects will allow the Department's research in superconductivity to move onto the Trumpington Street site, the Centre for Sustainable Development to move alongside the Engineering Design Centre, the accommodation of new activity in the Life Sciences and ultimately the withdrawal from the rented space on the Science Park.

These are all in addition to the projects supported by the last HEFCE funding round, which are either complete or scheduled for completion over the summer.

We have also pushed ahead on our three research themes: engineering for life sciences; cognitive systems; and sustainable development. Professor Daniel Wolpert will join us from University College London to strengthen our work on engineering for life sciences. A new appointment in cognitive systems will be announced soon, as this theme gathers pace. Those involved in sustainable development are engaging with the wider University and developing some major new research proposals.

Many other actions are in progress in the areas of teaching, fundraising, provision of services to academics on the West Cambridge Site, financial management, and preparation for the next Research Assessment Exercise.

The strategic actions are starting to deliver tangible results, but much more hard work lies ahead to ensure that the Department maintains and extends its international reputation for excellence in teaching and research. The stories in this newsletter showcase a few of the recent activities in our Department where over 130 academics teach over 1000 undergraduates and lead over 350 research projects. If you find them of interest and want to know more, then please visit our website (www.eng.cam.ac.uk) or contact our Director of Research (Philip Guildford, 01223 332671, pg28@cam.ac.uk).

Further information:
The Department's strategy can be found at www.eng.cam.ac.uk/news/stories/strategy

Professor Daniel Wolpert

Professor Daniel Wolpert joins the Department

Professor Daniel Wolpert has been appointed to the Professorship of Engineering (1875) to develop Engineering for the Life Sciences, a key theme within the Department's strategy. The Department is promoting a number of research themes that address major global challenges and are likely to attract high levels of external interest. Engineering for the Life Sciences offers a significant opportunity as the demand grows for a quantitative mechanistic understanding of biological systems. Professor Wolpert will join the Department in September 2005 to help co-ordinate research and teaching that relate to the interplay between Engineering and the Biological and Medical Sciences.

Daniel Wolpert studied medical sciences at Cambridge and clinical medicine at Oxford. He then worked as a medical doctor for a year before returning to Oxford to earn his DPhil in Physiology. After a postdoctoral fellowship in the Department of Brain and Cognitive Sciences at MIT, he joined the Institute of Neurology, UCL. He is currently Professor of Motor Neuroscience and Co-director of the Institute of Movement Neuroscience at UCL. In 2004 he was elected a Fellow of the Academy of Medical Sciences.

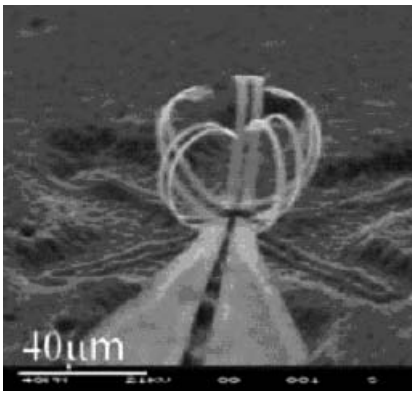
The principal objective of Daniel Wolpert's research programme is to investigate the computational processes that the central nervous system uses in human sensorimotor control. His group uses computational techniques from machine learning, control theory and signal processing, together with novel experimental techniques that include robotic interfaces and virtual reality systems, to investigate the computational principles underlying skilled motor behaviour.

Professor Wolpert is excited about the prospect of developing Engineering for the Life Sciences within the Department. "I see tremendous opportunities to further promote interdisciplinary research and teaching within engineering and the medical and biological sciences," he says. "I am delighted that Cambridge is taking a leading role in this dynamic and rapidly expanding field."

Further information:
Engineering for the Life Sciences theme www-g.eng.cam.ac.uk/lifesciences/
Department of Engineering strategy www.eng.cam.ac.uk/news/stories/strategy/
Professor Daniel Wolpert's current research www.wolpertlab.com

Microcage grasping device holds biological cells without damage

Researchers in the Electron Device Material (EDM) group have developed a technology to fabricate multi-fingered microcages with a diameter of ~40μm. This device is suitable for trapping and holding biological specimens such as cells without applying a force directly on it, thus avoiding damage to the cell. This device is made from a metal and Diamond-Like Carbon (DLC) bimorph



structure. The compressively stressed DLC layer expands once the bimorph structure is released from the substrate, and forms a closed microcage. A pulsed current of <10mA with duration of milliseconds can be applied to generate a thermal stress on the metal side, and force the microcage to open. The power to open the microcage is less than 20mW. The advantage of a pulsed operation is to keep the device temperature lower, thus they can be used for biological applications.

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Further information:
To find out more about the activities of microsystems (or MEMS) at EDM group, visit the website: www.eng.cam.ac.uk/research/div-b/ edm/research.html#mems

This research comes under the umbrella of the new Centre for Advanced Photonics and Electronics (CAPE) project www.admin.cam.ac.uk/news/dp/2004101501, and was sponsored by Cambridge-MIT Institute (CMI) www.cambridge-mit.org

Visual instruction manual on your mobile – researchers bring sight to computers

Anyone who has struggled to find the on-off switch on the computer will appreciate a new technology being developed by researchers here at the Department of Engineering.

In future you will be able to point your mobile phone camera at the offending piece of equipment and a computer-generated arrow will indicate where the elusive button is located. The same goes for the water bottle in the car, the release catch for the bonnet, the toner cartridge in the printer and so on.

Dr Tom Drummond's work in Augmented Reality has a variety of applications as he explains: "Augmented reality is about taking computer graphics and interfaces away from the computer screen and into the real world. We do this by using a video camera and intercepting the video before it reaches the viewfinder. Computer generated graphics are then added to the video so that the user sees an image of the real world overlaid with context sensitive information. Put simply, this gives the end user the ability to indicate 'this one' to the computer."

Work by the researchers, will radically improve fault diagnosis and maintenance checks. Dr Drummond sees a future when the instruction manual is provided electronically for loading on to your computer, PDA or even mobile phone.

Photo: Holdsworth Associates

Visual instruction manual on your mobile

For example, in one demonstration a faulty printer is viewed as a video image on a tablet computer and then overlaid with a computer generated graphic. By touching the real world image on the computer screen the user is taken through a series of checks to eliminate the problem.

Dr Drummond is talking to a number of organisations about how the technology can be used to enable collaboration between remote parties, for example to improve safety in stadiums by improving coordination of ground operations from a central control point. These are situations where both parties have a different view point and may have information about specific locations that at present would be difficult to communicate effectively.

Other exciting applications include the film and computer game industries, where virtual characters can be placed into a real scene. The team have developed a prototype which uses a computer game to illustrate some of the more advanced capabilities of their Augmented Reality system.

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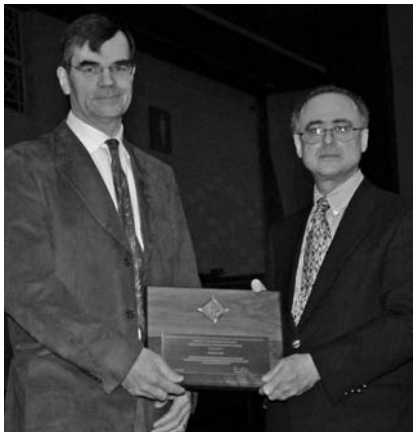

Professor Steve Young receives award

Professor Steve Young receives IEEE Technical Achievement Award 2004

Professor Steve Young, Head of the Information Engineering Division, has been awarded one of the two 2004 Technical Achievement Awards of the IEEE (Institute of Electrical and Electronics Engineers, Inc.) Signal Processing Society. The citation Steve received for this prestigious award stated 'For his outstanding contributions to the advancement of the theory and performance of speech technology, including speech recognition, spoken language understanding, and dialog systems'. Information on the award can be found at this web address: www.ieee.org/organizations/ society/sp/techachv.html

The Silent Aircraft Initiative – a new approach

Reducing aircraft noise is rising up the agenda of environmental issues. Not only are greater demands being imposed for greener aircraft, so too are parallel demands that they should be quieter – much quieter. The Department of Engineering's Silent Aircraft Initiative, funded by the Cambridge-MIT Institute, is a new approach, taking low noise as the most important design objective and working with a wide range of partners to come up with a truly novel solution. Set up as a Knowledge Integration Community, with knowledge exchange as its core driver, the Silent Aircraft Initiative aims to change the way aerospace research is undertaken, through extensive collaboration with a much wider franchise of stakeholders than ever before.

The Silent Aircraft Initiative

The project is run jointly between the University of Cambridge and the Massachusetts Institute of Technology.

Further information:
Visit silentaircraft.org and www.cambridge-mit.org/cgi-bin/default.pl

The report commissioned by the Department of Health and the Design Council

Patient safety research wins award

In the USA it is estimated that at least 44,000, and perhaps as many as 98,000 die in hospitals each year as a result of medical errors. Even using the lower estimate these deaths exceed those attributed to breast cancer, AIDS and motor vehicle accidents. As many as half of these adverse events are judged to be avoidable. Reducing this disturbing toll of human lives requires a rethink of the approach towards medical safety.

A study undertaken by research teams at the Engineering Design Centre (EDC), Department of Engineering, University of Cambridge, the Robens Centre for Health Ergonomics at the University of Surrey, and the Helen Hamlyn Research Centre at the Royal College of Art, has led to the publication of a report which points the way to improving patient safety and will contribute significantly to improving the quality of care for NHS patients. The study identified how the effective use of design could help to reduce medical accidents.

The report "Design for patient safety – a system-wide design-led approach to tackling patient safety in the NHS", which can be found at http://www-edc.eng.cam.ac.uk/medical/downloads/report.pdf was jointly commissioned by the Department of Health and the Design Council, has been recognised by The Ergonomics Society with the award of their President's Medal: "This medal is to honour institutions or organisational groups whose work has made a significant contribution to original research, the development of methodology, or application of knowledge within the field of ergonomics."

The report is beautifully presented, with illustrations relating to the subject matter and is available from the Design Council or Department of Health.

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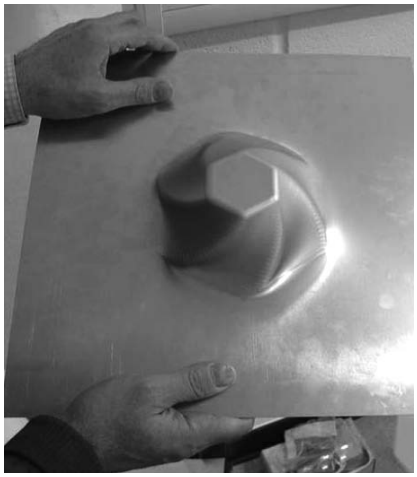
Incremental forming tool in action



Incremental sheet forming

Incremental sheet forming

Most manufacturing involves 'adding to' or 'removing from' a material. Dr Julian Allwood and Doctoral Student Kathryn Jackson are working on a unique manufacturing process which reforms material into a new shape.

Incremental Sheet Forming (ISF) is an alternative to metal pressing or stamping. Pressing requires specialist tooling for each product, which is expensive and difficult to design. This means, in turn, that pressing requires large batch volumes to offset tooling costs. In incremental sheet forming, an indentor tracks round the work piece, creating small 'kinks' in the material, incrementally developing any chosen shape. This leads to lower production rates, but no tooling costs, and is potentially an attractive solution for flexible low-volume manufacturing.

Possible applications include: providing any car body part from a stock of standard sheets, greatly reducing the need for mass distribution of spares and offering a solution when spares are not available; custom-made medical braces such as ankle supports; and bespoke architectural features.

ISF was first explored at the Institute for Manufacturing in 1990 by Colin Andrew, and then taken up in Japan during the 1990s. Most studies in ISF to date have been with one indenter only, and based around modified Computer Numerical Control (CNC) milling machines. A new incremental forming machine was commissioned in October 2004 at the Department's Institute for Manufacturing, which is the first dedicated rig to be built outside Japan. The machine is designed to be strong enough to form steel of the thickness used for car body panels. Additional features of the machine include built-in force measurement and space to accommodate a second indenter on the underside of the work-piece in the future.

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Further information:
Incremental sheet forming is one of several technologies for local production currently being researched by Dr. Julian Allwood. www.ifm.eng.cam.ac.uk/pp/projects/allwood-research.html#forming

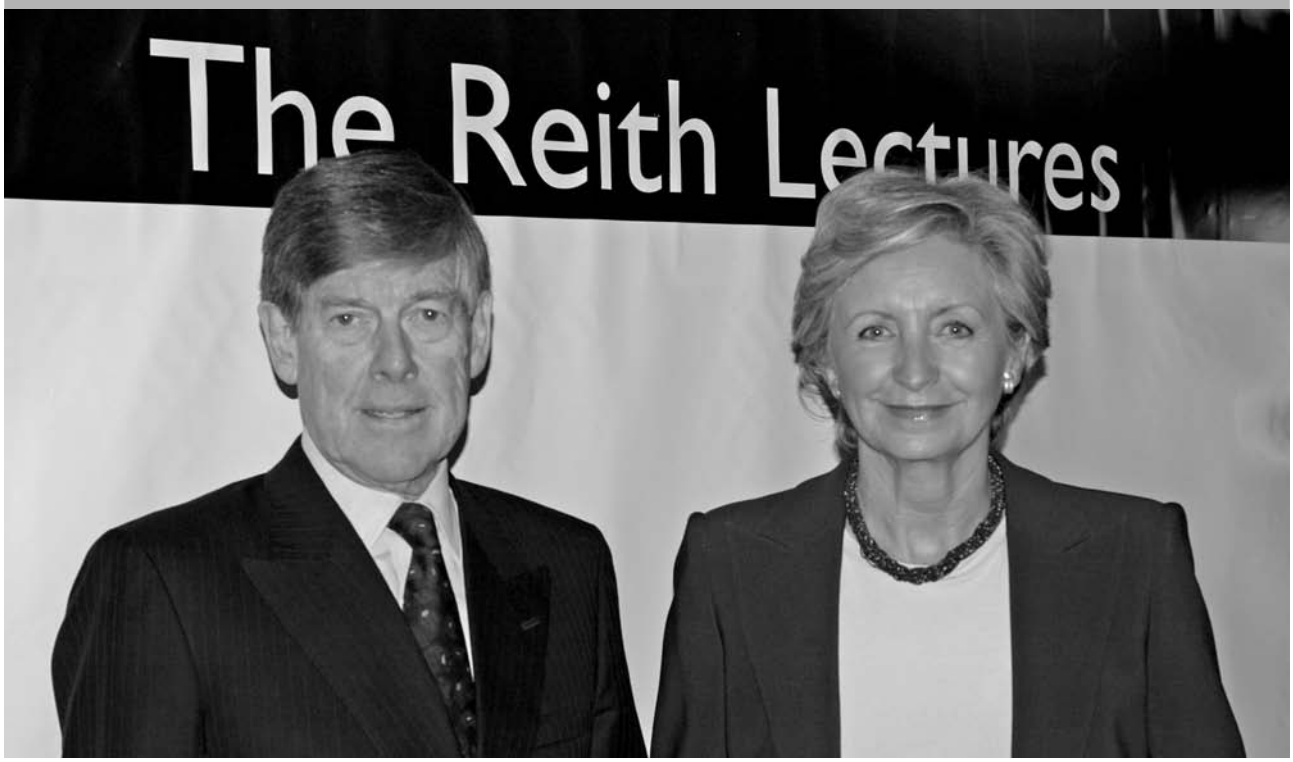
Prize pump for the world's poor

Thomas Smith, a research student from the Department, was named the L'Oréal-Royal Institution Science Graduate of the Year 2004, for his efforts to develop a cheap and efficient pump with no moving parts.

"By heating and cooling fluids, causing them to expand and contract in carefully shaped tubes, he has shown that it is possible to pump water higher than previously thought possible without mechanical engines. He has designed and built a device that can pump water to the top of a two-story building, inflate balloons and irrigate crops. He plans to exploit the technology through a company called Critical Point Dynamics and plough the revenues back into research." wrote Roger Highfield, Science Editor, The Daily Telegraph 23/06/04.

Prize pump for the world's poor

Further information:
Visit The Royal Institution website.
www.rigb.org/rimain/news/newsdetail.jsp?&comp=1&id=19&lang=EN



Lord Broers and Sue Lawley, Reith Lecture

Lord Broers' Reith Lecture

Lord Broers gave the second of the BBC's prestigious Reith lectures at the Department of Engineering. Lord Broers chose the Department as a venue, because it represents home turf. He studied and conducted his first research in the Department of Engineering. He later returned to be the Professor of Electrical Engineering in the Department (1984–96) and then the Head of Department (1993–96), before becoming the University's Vice Chancellor (1996–2003).

In the five lectures, entitled 'The Triumph of Technology', he sets out his belief that technology can and should hold the key to the future. In the Cambridge lecture, Lord Broers showed how collaboration lies at the centre of technological innovation. He explained that the era has passed when individuals could achieve significant advances while working in isolation. Technology research needs team work to engage the full spectrum of expertise and if breakthroughs are to be achieved then very often these teams must be international.

Lord Broers says: "I have chosen technology as the subject of my Reith Lectures because it is exciting and fast moving and because it shapes our lives.

Technology provides the means for the third world to join the first world and, besides, if we do not understand it better we will fall behind in our own intellectual, social and material development.

I have spent my life creating technology and it is a huge privilege to be given this chance to explain its importance."

Lord Broers was succeeded by Professor David Newland, and then by Professor Keith Glover as Head of the Department of Engineering. Professor Glover published the Department's new strategy last year, which features three major themes: engineering for life sciences; cognitive systems engineering; and sustainable development. Implementation of this strategy is well underway. It includes the creation of the Centre for Advanced Photonics and Electronics (CAPE), which embodies the Electrical Engineering Division. Professor Bill Milne, the Director of CAPE, has worked with his colleagues to secure substantial funding from the Government for the new laboratory on the West Cambridge Site, strategic partners from industry, and an exciting portfolio of research projects. CAPE is already up and running. It will move into its new building at the beginning of 2006.

The lecture chaired by Sue Lawley was broadcast on BBC Radio 4. You can listen to the series of five lectures or read a full transcript on the BBC website www.bbc.co.uk/radio4/reith2005/schedule.shtml

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Further information:
Profile of Lord Broers www.raeng.org.uk/about/fellowship/fame/broers.htm
BBC Reith lecture website www.bbc.co.uk/radio4/reith/
Department of Engineering strategy www.eng.cam.ac.uk/news/stories/strategy/
CAPE press release www.admin.cam.ac.uk/news/dp/2004101501
CAPE webcam www-building.arct.cam.ac.uk/westc/CAPE/webcams.html

3D Scalable Integrated Displays

3D Scalable Integrated Displays

Until now 3D displays have been developed for only one viewer. Christian Moller a research student here at the Department is working on a 3D display where the viewing zone is equal to that of any television allowing an unlimited number of people to view at any one time. The display is very easy to scale and is flat panel. Part of the success of this new display is being able to use the Wedge technology developed by Dr Adrian Travis here at the Department to make this display flat panel. www.eng.cam.ac.uk/news/stories/flatscreen_tv/

The technology produces a holographic experience and has a combination of properties that make it unique:

- True 3D, you can look around objects by moving the head sideways
- No restriction in head movement or number of viewers
- Full colour and full resolution
- Flat panel
- No headgear or head tracking equipment

This £1.5m applied research project is developing the building blocks for a 3D digital display system that can be applied to a wide range of the most demanding applications in visualisation, simulation, cinema and entertainment. The collaborators include two of the UK's leading companies in digital projection and image processing working together with the Department of Engineering. The results of this project could give the UK new access to markets for visualisation technology, active 3D cinematic display and a range of specialist scientific applications.

Setred has been set up as a spin-out company, in order to commercialise this ground-breaking research. www.setred.com/ Setred was set up as a result of the Cambridge University Entrepreneurs £50K Business Creation Competition.

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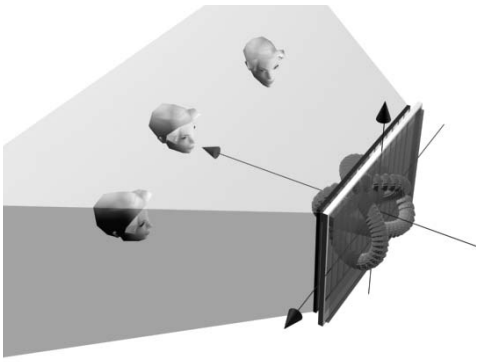

3D display with a wide field of view

EPSRC awards £2m for major university/industry collaboration in the inkjet sector

The Engineering and Physical Sciences Research Council (EPSRC), the UK Government's leading funding agency for research and training in engineering and the physical sciences, has awarded a new research grant of just under £2m to a major university/industry collaboration in the inkjet sector. The initiative's industry partners – Domino UK Ltd, Sericol Group Ltd, Linx Printing Technologies plc, Fujifilm Electronic Imaging Ltd, Xaar plc, Cambridge Display Technology Ltd (CDT), Inca Digital Printers Ltd, Plastic Logic Ltd and Sun Chemical Ltd – have provided a further £1m of match-funding. The university partners are the Universities of Cambridge, Oxford, Leeds, Manchester and Aberystwyth, with the University of Cambridge being the administrator of the funds.

This significant collaboration is the first of its kind for the world-leading inkjet industry in the UK and reflects the partners' commitment to advancing science and technology developments relevant to their sector. The combined funding of approximately £3m will support a five-year programme of research and development that will be co-ordinated by the University of Cambridge and be focused on a dedicated laboratory based at Cambridge's Institute for Manufacturing, a part of the Department of Engineering. The Chemical Engineering and Maths Departments at Cambridge are also involved in the consortium.

The industry partners will work closely with the universities involved to try to develop commercially the scientific possibilities that emerge from the research. Currently the world market for industrial printing includes packages, cartons, wallpapers, textiles and laminates and is valued in excess of £100bn. It is anticipated that new applications for the production of polymer-based TV displays and electronics products such as printed integrated circuits will be developed in addition to the ongoing development of the traditional graphical applications for the inkjet industry. The potential market size in the display area alone is of the order of $30bn and the possibilities for low-cost plastic circuits, manufactured using inkjet, may be greater still.

The emerging science behind these developments in the industry is the Drop on Demand (DoD) technology used in office printing, known as 'digital' printing, which greatly improves the quality obtainable. It is expected to replace traditional Continuous Inkjet (CIJ) printing processes in many industrial applications. However, the higher accuracy and higher speeds required in the new applications of inkjet make demands beyond the current available technologies. In modern inkjet printing, jets and droplets are formed at extremely high speeds. The fluids used contain significant amounts of polymer and/or particulates and so have particularly complex rheological properties. The combination of these two things leads to complex and inadequately explained behaviour. The properties and behaviour of complex fluids at the very high shear rates involved in inkjet printing are currently poorly understood. An important aspect of the research will involve characterising and modelling these fluids. The small size of inkjet printhead components and the very tight tolerances required also pose problems of measurement.

New scientific understanding is required to support these emerging applications, which none of the consortium companies are able to develop on their own. Mutual links between the world-leading inkjet community in the UK, which originated in the Cambridge area, the University of Cambridge and the other universities working in the field, triggered an awareness of the need to pool resources to enable a serious level of scientific activity in this field.

"This EPSRC funding, combined with the match-funds from leading inkjet companies, is enabling an unprecedented level of university/industry collaboration for the UK's valuable inkjet industry. All the partners are very excited by the tremendous opportunities for serious scientific development and related commercial applications that this consortium promises to deliver. The expected outputs should revolutionise the inkjet sector for the UK and beyond."

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