

CEB Focus

Department of Chemical Engineering and Biotechnology
Michaelmas 2010

Issue 1



*Professor Nigel Slater
New Head of Department*

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Welcome



*Professor Lynn Gladden,
Pro Vice-Chancellor for
Research and former
Head of Department*

Welcome to the first issue of CEB Focus, the newsletter of the Department of Chemical Engineering and Biotechnology.

As a recently merged department, this newsletter intends to continually build bonds between our three sites and keep our stakeholders informed about our teaching and research activities and developments as well as to highlight our people's achievements.

We would like to make our alumni and research and industry partners part of our success.

As we move into a new academic year and I step down as Head of Department (HoD), I have no doubt that the Department will

go from strength to strength under the leadership of our new HoD, Professor Nigel Slater.

A few of the many achievements of our department as a whole and of key individuals are summarised in this issue. Teaching and research highlights, including undergraduate matters and relevant events, are also covered, as well as recent arrivals and departures. Finally, a light-hearted tea-room teaser is featured. Please note that your comments and feedback are always welcome, which will be published under the 'Letters to the Editor' section.

Editorial

The Editorial team welcomes you to the CEB Focus Launch Issue!

It has been of immense importance to us to get a representative newsletter started, ensuring that the information communicated reflects the new identity of the merged department. We have representatives from the Chemical Engineering, Biotechnology and MRRC sites generating ideas, providing input, and liaising with academics, research groups and students in order to make this possible. Contributions from department members and corporate partners are much appreciated and it is hoped that this will continue. We welcome our readers to contribute their research and ideas to help us carry on.

If you have any comments or suggestions for articles to be included in the next issue, please get in touch with the Editorial Team on ceb-focus@ceb.cam.ac.uk

We look forward to hearing from you!

For those wishing to receive a regular copy of **CEB Focus** electronically please subscribe by sending a message to ceb-news-request@lists.cam.ac.uk with 'subscribe' as the subject of the message.



Left to right: Elena Gonzalez, Sohini Chakrabortee, Alastair Clarke, Amy Chesterton and Fernando Abegão



*Professor Nigel Slater,
Head of Department*

Ex antiquis et novissimis optima ***(‘The best out of the old and the new’)***

As the newly incumbent Head of Department, I welcome you warmly to the first issue of the new **CEB Focus**, a mouthpiece of what is still a relatively new Department of Chemical Engineering and Biotechnology. Granted, it is odd for someone who was thrown out of Latin classes at age eleven to write under this heading, my college motto, but ‘The Best of the Old and the New’ is precisely what we intend to do; the best of the two old institutions in one new department. Collectively, we have made enormous strides over the past decade; the merger itself, record undergraduate numbers, top of the Chemical Engineering rankings in the 2008 Research Assessment Exercise, the Queen’s Anniversary Prize to Biotechnology, huge research output, many distinguished awards to staff and the success of the Masters programmes in Bioscience Enterprise and Advanced Chemical Engineering. Underlying all these achievements are the immense efforts of our academic and support staff right across the department, and in particular Professors Chase, Gladden and Lowe, who have led Chemical Engineering and Biotechnology through this decade.

Where now? Quite simply, our goal is to provide the new generation of chemical engineers and

biotechnologists with the outstanding educational foundations that they will need to compete professionally on the international stage and to be a leader in their chosen field. We believe passionately that society needs outstanding engineers and technologists with the skills, vision and confidence that will be required to tackle the big challenges that face their generation; be they economic, environmental, or sustainability and healthcare. I get a tremendous buzz in seeing our students grow in professional stature as a result of our influence and in this way, too, we really do achieve the best of the old and the new.

So, the pursuit of our goal is an exciting venture and it is one in which we invite all our friends and alumni to join. They, too, are stakeholders in the reputation and traditions of the department and they, too, share our goal. Certainly, in the current economic times we need financial support to provide modern facilities in which we can unite the department on one site. But the support we need is not only, or even mainly, financial. We need access to the commercial and professional experience of our alumni, we wish to benefit institutionally from their influence and contacts and we are eager to learn from their valuable advice and guidance. So, a promise, if any of our friends and alumni would like to join us in our venture then please either call or write to me and I shall be delighted to discuss how that might be done. It will, of course, be an even greater pleasure for me to welcome our friends and alumni in the department so that they can experience the same buzz that I feel.

Please note on-line CUCB platforms on LinkedIn, Facebook and Twitter have been created to help our alumni get career advice from other members, reconnect with old friends. These networks help them keep in touch with department members and be informed about our relevant events. Most importantly, these are platforms where they can voice their views and concerns.

Message from Head of Department

My journey

Shortly after arriving back in Cambridge in 2000, I wrote for ChemE Interfaces *"working in familiar surroundings with old colleagues ... has been very stimulating. The majority of the staff are young academics with exciting ideas, a clear vitality and with a vision for their teaching and research that promises well for the future of the department and for the profession. The building has been extensively refurbished and the facilities are well matched to the needs of modern research in our rapidly evolving discipline. Most stimulating though is the obvious enthusiasm for applying modern analytical methods for the study of complex products and processes, which is testing the conventional boundaries of the discipline."* A decade later these qualities are still as stimulating as they were then and underpin the success that the department has had in the intervening time.

Looking further back, these same Cambridge qualities led to my arrival in the department. As a student at Sidney Sussex, John Agar would talk passionately

A decade later these qualities are still as stimulating as they were then and underpin the success that the department has had in the intervening time.

about irreversible thermodynamics rather than IA chemistry and though I understood not a word the magic was irresistible. My PhD apprenticeship to David Husain in Physical Chemistry proved an immensely rich and valuable lifelong experience and led to my first tentative steps in academia as a Junior Research Fellow at Fitzwilliam College ("Fitz") in 1978. There, a chance discussion with Nigel Kenney over lunch resulted in an appointment as an Assistant Lecturer in Chemical Engineering in 1979 – a position that is no longer advertised for being too lowly. An odd position too; a chemical engineering student in the morning, a supervisor in the afternoon and a researcher out of term. But what an experience under John Davidson's leadership and one that led to a Lectureship in 1982.

What was then planned as a one year industry secondment led to ten years in *"the real world"* – except that it was no more or less real than life in Cambridge; research funding had to be secured, milestones met in our projects, reports written and presentations given. I returned to academia in 1995 as Head of the Department of Chemical Engineering and Applied Chemistry at Aston University, leaving a laboratory of 120 scientists and engineers on a Friday evening and arriving on my own in a completely empty lab the following Monday.

I see the challenge to build on the department's excellence in teaching and research by maintaining its pole position in the forthcoming Research Excellence Framework.

Somehow, things moved forward; I secured some grants to pursue my research interests in biochemical engineering and was allowed to recruit some young staff. We built momentum and soon after I left in 2000 the School reached the top ranking in Research Assessment.

So, finally back to Cambridge and Fitz as a Professor of Chemical Engineering in 2000; in all, it has taken me 31 years to move three doors down the corridor. I also became President of Fitz in 2009 – a post without any discernible job description, but very rewarding because Nigel Kenney had held it previously. Looking forward, I see the challenge to build on the department's excellence in teaching and research by maintaining its pole position in the forthcoming Research Excellence Framework, enhancing its infrastructure and environment and strengthening the training offerings.

Do I still find the department stimulating?

You bet I do!

New CUCES Committee 2010-2011

Annual elections have taken place to elect a new committee for the Cambridge University Chemical Engineering Society (CUCES). In Lent term, undergraduates packed the tea-room and voted-by-ballot for their preferred candidates. They chose to take the society in a fresh direction with all available positions going to students with no previous CUCES experience.

Constantinos Pittas will take over from Annie Spencer as the new CUCES president. Rikita Sood is the new treasurer and Vin Rajendran, the new secretary. Mgawa Mkandawire continues as the Part I representative until the new students arrive this term. Naveed Kayaam (Frank Morton), Zam Shabeer Thahir (IT and Publicity) and Anna Kvarngren (Events and Careers) have also been elected. The Events and Careers representative is a new position. According to Constantinos, this reflects *"the increasing attention CUCES gives to the career-related issues of its members."*

CUCES is a student-run society that organises events for undergraduate and postgraduate members of the department. They lead *technical* evenings intended to act as a conduit between students and potential employers from industry, as well as organising social events such as the CUCES annual dinner.

New president Constantinos Pittas plans to build on the success of CUCES. *"The current committee promises to work for the best interests of the students and the Department and to maintain and strengthen the already very strong family spirit that exists and distinguishes us as a department. We are extremely grateful to the department, and companies such as BP, ExxonMobil and Shell for providing us with a platform to do this."*

And the CUCES president has already got some ideas for the future. *"We plan to create a CUCES career questionnaire to gauge on the types of careers that students are seeking and then organise an internship event where older students, and potentially representatives from the industry, can network with us and share their knowledge and experiences."*

For more information on the activities of CUCES, please visit the website: www.srcf.ucam.org/cuces



Mgawa Mkandawire (far left) with the Committee members: Vin Rajendran, Zam Thahir, Rikita Sood, Naveed Kayaam, Constantinos Pittas (President) and Anna Kvarngren

Summer Internship Experiences

During the summer months, some undergraduates decide to take part in internship programmes with chemical engineering companies. Three students describe their experiences below.

BiogenGreenfinch

Rici Marshall

This summer I have been working at BiogenGreenfinch, a company who design, build and operate anaerobic digestion plants.

Anaerobic digestion (AD) is a means of producing energy from waste food. Anaerobic bacteria are used to break down the macro-molecules found in waste into small substrates for methane-producing bacteria. The methane is then used to produce electricity and heat, and the by-product can be used as fertiliser.

BiogenGreenfinch is a fairly small company split over two offices. I was working in the Ludlow office where the technology and innovations teams are based. My project looked at the science behind AD odours and tried to find technologies that mitigate them. The AD process produces a number of unwelcome smells and the future success of AD relies on these being controlled. Different people will respond differently to a given odour in different environments; it is certainly not easy to measure this effect quantitatively! Once I identified the cause of the odours

and understood the chemistry of aerobic and anaerobic digestion, stagnation and combustion, I was then able to conduct on-site experiments and identify chemicals found at the plant. I reviewed a range of odour mitigation technologies to find the best one for BiogenGreenfinch. I presented my results in a report and talk. Although there is no clear solution, it has been a useful project to both the company and to me.

Air Liquide UK

Naveed Kayaam

I have just completed an eight-week internship at Air Liquide, UK. Air Liquide, a French-based company, is the world leader in gases for industrial, medical and environmental use. I had two projects concerning a methane plant located at Stoke. The first project looked at analysing the feasibility of restoring and

running a shut-down plant in parallel. The other looked at the feasibility of switching from a steam-driven heat exchanger to an electrical unit. My work involved plenty of engineering calculations, as well as helping to keep the filing systems of all the completed engineering jobs up-to-date. As part of my internship, I also enjoyed several trips to Stoke.

At times I would wonder why I am working and not enjoying my holidays, but by the end of the internship the knowledge and experience I had gained was priceless. Saying this, I was paid a decent amount which would come in handy for the rest of the holidays! I would recommend students entering Part IIA to start applying for internships straight away. When applying try applying to smaller firms as well, as the competition for the bigger ones is pretty intense.



Naveed Kayaam at Air Liquide plant, Stoke

Dow Chemicals

Ritika Sood

This summer, I spent six weeks working at Dow Chemical at its European headquarters in Horgen, Switzerland. I worked on a market research project on biosolvents, which are green solvents derived from renewable raw materials. This research reflects the recent surge for natural, sustainable products in the cosmetics industry. Given there are different interpretations of what a "green biosolvent" is, part of my research was to propose a definition which is applicable for all industries and takes into account their impact on the environment and on human health. I also researched the current market standing and growth potential of biosolvents as part of my work.

The whole experience was both enjoyable and educational. I gained a fascinating insight into how international companies work. My boss was not located in Switzerland, but in Rheinmünster, Germany and this made meetings an interesting experience! At the end of the internship, I had to give a presentation to an audience participating from three different continents, attending either in person or via a conference call.

CEB students make connections between science and art

Sandy Kwok and Leo Martinez-Hurtado, both CEB students, expressed scientific research in an unconventional manner in September, for a "*Dance your PhD*" competition. They helped Radek Lach from the Wellcome Trust Sanger Institute transpose his research on synthetic lethal interactions in cancer into choreography.

The CEB students scripted the research project into dance movements. They invested hours of hard work together with other volunteers to explain in dance the process of screening for synthetic lethal interactions between cancer genes and small molecules. You can judge whether they succeeded, by watching the results at <http://tinyurl.com/CEB-PhD-dance> and observing that scientists can actually dance.

The competition was launched by GonzoLabs (<http://gonzolabs.org>) along with the support of The American Association for the Advancement of Science (AAAS) to intertwine science and art. This year the competition for science PhD students ran for the third time. It provides an opportunity for young scientists to get the spotlight with their research projects and to highlight the beginning of their academic carrier. The winners get \$1000 and enjoy a lot of publicity, including screening at the Imagine Science Film Festival in New York City and coverage in the Science magazine.

This year's winners will be announced on 24 October 2010.



Sandy and Leo rehearsing

IChemE accreditation of MEng degree renewed through to 2014/15

Dr David Scott

In May, the department's undergraduate course for the Masters of Engineering (MEng) degree was assessed by accreditors from the Institution of Chemical Engineers (IChemE). The accreditors looked at documentation provided by the department, and talked to many of its members, including academics, support staff and students. We are pleased to report that the course has been re-accredited for 5 years from 2010 entry to the university.

IChemE accreditation provides benchmarking of academic programmes against high, internationally recognised standards, which is of increasing importance as the globalisation of engineering products and services demands greater confidence by employers in the skills and professionalism of the engineers they recruit. Further, an accredited degree helps provide a graduate with a straightforward pathway to qualification as a Chartered Chemical Engineer (MChemE). Graduates with a Masters-level accredited degree will have met the formal educational requirements for Chartered status membership in full; they will simply need to demonstrate that they have acquired professional competency following a period of relevant training and experience post graduation.

Cambridge – Beijing Summer School Launch: an international exchange venture



BUCT students in the lab

Dr Kamran Yunus

The first Cambridge-Beijing Summer School was hosted last July in Cambridge. This course was attended by students and academics from the Beijing University of Chemical Technology (BUCT), and during the 10-day programme, a series of

lectures and seminars were delivered by CEB members and invited speakers from industry.

The event focused on providing an overview for research activities in the department and outreach to international students; and in engaging with the emerging Asian markets in Science and Technology. Looking ahead, the course aims to open admissions for students across Asia, in the anticipation of engagement with top universities from China, Malaysia and Singapore.

The course delivered an insight into the evolving field of chemical engineering and biotechnology and its broad range of cross-disciplinary activities. The programme covered research topics such as multi-scale reaction engineering, renewable energy and biotechnology. A series of workshops were used to promote awareness in R&D trends being pursued at CEB in Cambridge.

As a result of this successful undertaking, Professor Gladden was invited to visit BUCT. She attended a ceremony in Beijing on September, when she was appointed Honorary BUCT Professor.



New Teaching staff

Dr David Scott

Michaelmas Term 2010 will see some changes to the teaching staff in the department.



Dr Axel Zeitler

has been appointed as a University Lecturer. Axel graduated in

Pharmacy and Chemistry at the University of Wurzburg, Germany, in 2002. He gained a Postgraduate Certificate and PhD in Pharmaceutical Technology from the University of Otago on the applications of terahertz (THz) radiation to the pharmaceutical sciences. During his PhD, he was a visiting student at the Cavendish Laboratory working with Professor Sir Michael Pepper and TeraView Ltd.. After completing his PhD, he returned to Cambridge to work as a Postdoctoral Research Associate with Professor Lynn Gladden, and in 2008 he joined Gonville and Caius College as a Fellow. His research interests have evolved from the characterisation of pharmaceuticals solids and film coating into molecular interaction in solids and liquids. He has started to work with Professor Gladden and Dr McGregor in applications of THz spectroscopy in catalysis. In addition, he is interested in how THz and MRI can be used complementarily. He enjoys travelling and having good food!



Dr Bart

Hallmark has been appointed as Design Lecturer to run the Design

Project. He will also be involved in other undergraduate coursework and in the postgraduate transferable skills programme. Bart gained his MEng and PhD degrees in CEB where he has been a postdoctoral researcher since 2005, working in the Polymer Fluids group on microcapillary films, amongst other topics. For the last two years, he has been a Temporary Lecturer and ran the 2010 Design Project on 'Glyphosate production' in conjunction with Dow Chemicals. He fills his spare time with outdoor activities, including mountain biking and downhill skiing, alongside maintaining a 1972 series III Land Rover. He also spent nine months in 2000 and 2001 as a crew member on a round-the-world yacht race.



Dr James

McGregor has been appointed as a Temporary Lecturer. James graduated with

a Master of Chemistry from the University of Edinburgh in 2002 and completed a PhD in heterogeneous catalysis at the University of Cambridge in 2006, under the supervision of Professor Lynn Gladden. Since then, he has been a Research Associate working in the Magnetic Resonance and Catalysis group at CEB. His research has focused on the catalytic transformations of hydrocarbons, in particular hydrogenation and dehydrogenation reactions. A common theme throughout his research has been the role of coke in catalytic reactions. The role of carbon deposits in facilitating the non-oxidative dehydrogenation of light alkanes has been the subject of a patent application. In 2009, he worked for four months as a guest scientist in the group of Professor Robert Schlögl at the Fritz-Haber Institute, Berlin. He is a Member of the Royal Society of Chemistry and an Associate Member of the IChemE.

Teaching Matters continued ...

Education and Industry together at Dow King's Lynn

Emma Harding, Dow

The *Design Project* is a key part of the Part IIA (3rd year) Chemical Engineering Tripos at Cambridge. In May and June 2009, students were asked to design a process for the manufacture of a commonly-used herbicide. The project was developed in partnership with Dow. A total of 80 students and staff visited Dow's King's Lynn site where they were hosted by Dow employees: Bob Guy, Carla English, Gary Backhouse and Kevinecticides. Roper. They received a tour of the facilities used to make Styrofoam and insecticides.

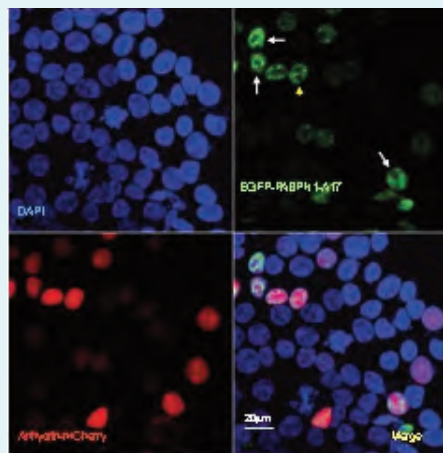
After an intensive five weeks, students presented their solutions to a judging panel which included Martin Tooley, Global Improvement Leader for Dow Agrosciences. Martin was instrumental in setting up the partnership with Cambridge, working with Dr Bart Hallmark, Lecturer at the Department of Chemical Engineering and Biotechnology.

Martin feels that such collaborations are essential for the company and students alike. *"Partnerships such as these are incredibly valuable. They allow the students to work on vocational projects which give them an insight into the industrial applications of what they are studying. In turn, we get a fresh perspective from young and enquiring minds."*

Bart agrees with Martin on the benefit to the students. *"Working with a leading global chemical manufacturer, such as Dow, provides excellent experience for our students. In particular, the chance to spend time out of the classroom and at a manufacturing facility, seeing chemistry on an industrial scale and working on real issues, is incredibly important."*

Drying without dying: molecular mechanisms undertaken by anhydrobiotic organisms

Dr Sohini Chakrabortee, Postdoctoral Research Fellow



The figure shows nuclear localization of a molecular shield protein, anhydricin (red), in cultured human cells. GFP tagged PABPN1-A17 (poly adenine binding protein with 17 alanine repeats, green) is co-expressed in these cells, which form spontaneous aggregates (responsible for oculopharyngeal muscular dystrophy), marked with white arrowheads. The nuclei are highlighted in blue by DAPI staining.

Nearly seventy percent of our bodies are made of water and it is impossible for human beings and most other organisms to survive without water. However, some organisms can survive extreme water loss for indefinite periods; in the dry state, metabolism and life processes come to a halt, but resume on addition of water. This remarkable ability, called desiccation tolerance, or anhydrobiosis, is found across all biological kingdoms, including

animals and plants. A major area of research in Dr Alan Tunnacliffe's lab is to elucidate the machinery that confers desiccation tolerance; specifically my research focuses on the investigation of the molecular mechanisms of cellular protection by intrinsically disordered proteins (IDPs). Our lab has discovered two novel functions associated with the IDPs implicated in conferring desiccation tolerance in nematodes: that of a 'molecular shield' and catalytic activity.

A central theme of action of several of these IDPs is to reduce general protein aggregation in vitro during desiccation stress^{1,2}. To model their functions in a living system we over-express them in mammalian cell cultures, where also they display anti-aggregation properties and confer them partially tolerant towards mild desiccation². Here, they localise into various compartments of the cell, some are ubiquitously expressed in the cells while others show exclusively either nuclear or cytoplasmic localisation^{2,3}. One such example of an IDP that is exclusively expressed in the nucleus of the mammalian cells, is shown here.

Interestingly, we found that these IDPs can also reduce the aggregation of expanded polyglutamine and polyalanine containing proteins associated with Huntington's disease and oculopharyngeal muscular dystrophy, respectively; and the mechanism behind such anti-aggregation property in cells was inhibition of aggregate formation rather than their clearance by other cellular processes like autophagy or proteasomal degradation^{2,3}. Superficially such an activity resembles that of the well characterised class of proteins called chaperones that are confirmation-dependent, however, in collaboration with Gabi Kaminski (from Clemens Kaminski's group) we have demonstrated that the IDPs we study just loosely associate with their client proteins, maybe by creating an electrostatic and/or steric barrier, which is more consistent with a role that we have termed as 'molecular shields'³.

Anhydrin, one of the IDPs that has a molecular shield function, deserves special mention since it exhibits a second novel function as an endonuclease which can digest supercoiled, linear and chromatin linker DNA. This finding is particularly exciting since enzymes usually require precise three-dimensional positioning of residues at the active site, whereas our research suggests that this need not be the case and therefore extends the range of IDP functional categories to include catalysis³.

¹. LEA proteins prevent protein aggregation due to water stress. Goyal K, Walton LJ, Tunnacliffe A. *Biochem J*. 2005 May 15;388(Pt 1):151-7.

². Hydrophilic protein associated with desiccation tolerance exhibits broad protein stabilization function. Chakrabortee S, Boschetti C, Walton LJ, Sarkar S, Rubinshtein DC, Tunnacliffe A. *Proc Natl Acad Sci USA*. 2007; 104(46):18073-8.

³. Catalytic and chaperone-like functions in an intrinsically disordered protein associated with desiccation tolerance. Chakrabortee S, Meersman F, Kaminski Schierle GS, Bertoncini CW, McGee B, Kaminski CF, Tunnacliffe A. *Proc Natl Acad Sci USA*. 2010; 107 (37):16084-89.

Combating Mother-to-Child HIV Transmission

Stephen Gerrard, PhD Student



Anti-viral nipple shield

Mothers in sub-Saharan Africa are losing their babies through the transmission of the Human Immuno-deficiency Virus (HIV) while breastfeeding. This problem inspired five students including myself and a public health doctor at the 2008 International Design

Development Summit (ddsummit.org), to develop a potential solution that is cheap, effective and practical. Together we founded a team called JustMilk (www.justmilk.org), which proposed a novel modification to conventional nipple shields that allows antiviral compounds (known as microbicides) to be transferred into breast-milk. The mother places the nipple shield on her breast to cover her own nipple just before breastfeeding. The design aims to have the microbicide mix with the milk as the baby feeds and rapidly reduce viral infectivity within the milk.

Since 2008, JustMilk has grown to be an international open-collaboration between members of the Department of Chemical Engineering and Biotechnology at University of Cambridge, FHI (previously known as Family Health International), virology and microbicide experts at Drexel University College of Medicine, public health scientists and virology experts at University of California Berkley and public health scientists at PATH.

The initial lead microbicide tested for reduction in viral infectivity (performed at Drexel University) was sodium dodecyl sulfate (SDS), an ingredient found in toothpaste and other personal care products. At the levels found *in vitro* to rapidly reduce viral infectivity, researchers at Drexel found that SDS had no significant effects on the major immunological and nutritional components of breast-milk. For the nipple shield design, JustMilk proposed to have microbicides such as SDS impregnated into a replaceable textile disk which is then incorporated in the tip of the nipple shield. My research currently focuses on improving the controlled release of SDS and other active agents from the disk into the milk in a simulated breastfeeding environment.

Exxon Mobil Greenhouse development marks the next step in algae biofuels programme

Richard Scrase

Exxon Mobil Corporation and Synthetic Genomics Inc. (SGI) are opening a greenhouse facility enabling the next level of research and testing in their algae biofuels programme. The new facility, at SGI headquarters in La Jolla, California, will allow researchers to move from lab to industrial scale production by testing whether large-scale quantities of affordable fuel can be produced.

In the greenhouse facility, researchers will examine different growth systems for algae, such as open ponds and closed photo-bioreactors. They will evaluate various algae (natural and engineered strains) in these systems under a wide range of conditions, including varying temperatures, light levels and nutrient concentrations. They will also conduct research into other aspects of the algae fuel production process, including harvesting and bio-oil recovery operations.

Since ExxonMobil and SGI first announced the algae biofuels programme in the summer of 2009, researchers have made substantial progress at different scales of the process. A large number of

candidate algal strains have been isolated and/or engineered, and growth conditions to increase the productivity of these strains have been developed. Identification and testing of the preferred design characteristics of the different production systems was also performed. Finally, lifecycle and sustainability studies were carried out. The next major milestone in the programme, expected in mid-2011, is the opening of an outdoor test facility.

Besides contributing to reduction of the greenhouse gas emissions by consumption of CO₂ during its production, biofuel manufactured from algae-based bio-oils has other advantages. It contains similar molecules to petrol and diesel, so it could be distributed using the existing transport fuel infrastructure. Also, hydrocarbons from algae can be produced using land and water unsuitable for crops or food production and at much higher rates than from other plants. The algae potential yield is more than 2,000 gallons of fuel per acre per year, compared with 50 gallons for soy oil and 650 for palm oil.

If research and development milestones are successfully met, ExxonMobil expects to spend more than \$600 million on the algae biofuels programme over the next decade, \$300 million of which will be allocated to SGI.



Ithaka Life Sciences Ltd supporting new University spin out companies



Dr Paul Rodgers, Managing Director

Ithaka Life Sciences Ltd (www.ithaka.co.uk) is one of the UK's leading advisory and interim management services providers, specialising in growing life science businesses. We have a track record of starting new companies based around research from universities including University of Cambridge, and the Department of Chemical Engineering and Biotechnology in particular.

Dr Paul Rodgers, founder and MD of Ithaka, has played a significant role in helping take Psynova Neurotech (spin out company from Dr Sabine Bahn's research) from a concept through to the launch of VeriPsych™, the first and only blood test to aid a psychiatrist in the diagnosis of recent-onset schizophrenia. To quote Dr Sabine Bahn, the founder of Psynova: *"As Chairman of the Board Paul has provided wise advice and support across all aspects of the business. He has been a delight to work with and his efforts are greatly appreciated by all the team at Psynova."* Previously, Paul played a similar role in the formation and early years of Smart Holograms, one of Prof. Chris Lowe's many spin out

companies. Paul is also currently a Non-Executive Director of Paramata, a remote sensing company formed by Dr Adrian Stevenson and Prof. Chris Lowe.

Ithaka has also assisted Universities throughout the rest of the UK in:

- Undertaking reviews of life science technologies arising from basic research
- Commercial strategy: development and implementation from start up to exit, including exploitation of novel technologies and resources
- Business creation and business plan drafting
- Sourcing investment finance
- Interim management
- Technical, commercial and market evaluation
- Business development, strategic marketing and licensing.

If you are looking for assistance with commercialisation of technology in the life sciences sector please contact the Ithaka team on 01223 703146 or info@ithaka.co.uk



Developments at Psynova Neurotech Ltd



Psynova (www.psynova.com) was founded in 2005 by Professor Chris Lowe and Dr Sabine Bahn. The company is developing novel protein biomarkers for neuropsychiatric disorders such as schizophrenia and bipolar disorder.

From the outset, Psynova has operated a lean business model, establishing mainly academic and non-profit partnerships as a crucial part of the operation, including cooperation with the Stanley

Medical Research Institute (SMRI), a nonprofit organisation supporting research on the causes of and treatments for, schizophrenia and bipolar disorder. Biomarker discovery is performed in the Neuro-Psychiatric laboratory at the Department's Institute of Biotechnology, therefore Psynova can access commercially promising IP through a framework agreement with the University. Clinical samples for biomarker identification and validation are accessed from the Neuro-Psychiatric international group of clinical collaborators.

Psynova successfully led an application for grant funding in 2008 from the EU Framework 7 programme to build on this network of collaborators specifically for R&D on a biomarker-based diagnostic test for schizophrenia. As it became clear that a complex panel of biomarkers would be required for the schizophrenia test, the attraction of forming a partnership with a company that had proprietary multiplex assay technology was recognised. In 2008, Psynova entered a co-development and investment deal with Rules-Based Medicine Inc. that is providing the company with funding and complementary technology, and in 2010 the two companies launched VeriPsych™, the first and only blood test to aid a psychiatrist in the diagnosis of recent-onset schizophrenia.

Psynova is also exploring with pharmaceutical companies the use of its proprietary biomarkers in drug discovery and development through a collaborative project funded by the Innovative Medicines Initiative public-private partnership. The project started in 2009 and additional one-to-one collaborations with pharmaceutical companies are already emerging. Psynova now has a collaboration with Roche to develop a companion diagnostic for a novel drug in clinical development for the treatment of schizophrenia.

Shell Gourami Business Challenge 6-11 January 2011



Whatever the future holds, we'll need ambitious graduates to help us tackle the energy challenge.

If you're ready to test your potential in the international energy business, there's no better place to start than Gourami. This fictional country is the setting for Shell's Gourami Business Challenge - a five-day residential event that takes place in the UK.

Working with an international team of students, you'll develop and present a viable business plan for Shell in Gourami - facing realistic challenges and demanding time scales in everything from exploration and production to marketing. And if you show the qualities we're looking for, we may offer you a full-time job to take up when you graduate.

Application deadline: 1 November 2010
Shell is an equal opportunity employer.

Johnson Matthey and CEB: a history of collaboration

Dr Andy York

Johnson Matthey's businesses and research community have a long history of collaboration with chemical engineering at Cambridge. In August 2008 Johnson Matthey increased that commitment by providing a new level of input via both financial and in kind support to the newly founded Department of Chemical Engineering and Biotechnology. The company has an interest in seeing the new department succeed, and is keen to collaborate in many areas of research within the multi-scale sustainable reaction engineering envelope, and aims to help the department reinforce its reputation in this core competency. To aid the success, Johnson Matthey has installed a

research scientist in Cambridge for a 5 year secondment. In addition, as a result of direct additional funding this October we see the start of a number of PhD studentships, either part or fully funded by Johnson Matthey, with more studentships anticipated in forthcoming years. The new projects will concentrate on various novel areas of catalysis, of interest to Johnson Matthey and also within the catalysis community.

The first of these is a CASE PhD which aims to apply nuclear magnetic resonance (NMR) spectroscopic techniques and magnetic resonance imaging (MRI) to understanding new catalyst substrates used in diesel exhausts; the materials of particular interest are known as diesel particulate filters, in which the exhaust gas must pass through the wall structure of the material so removing harmful particulate matter from diesel exhausts. However, the processes and mechanisms involved in the operation and manufacture of these filter materials are not well understood, and this project aims to increase our detailed knowledge.

Both the other projects are directly funded by Johnson Matthey, with part of the funding supplied by the department, and will use NMR and MRI techniques to help solve fundamental problems that are found in heterogeneous catalytic reactions. One project will involve the development and application of para-hydrogen polarisation enhanced NMR/MRI techniques to help solve some of the fundamental mechanistic questions of catalytic hydrogenation of simple olefinic materials over supported precious metal catalysts. Para-hydrogen enhanced NMR provides a unique ability to enhance NMR signals by many orders of magnitude thereby enabling the study of systems previously inaccessible by conventional NMR/MRI methods. The combined use of para-hydrogen and NMR/MRI is unique in that it can be used to identify specific modes and mechanisms of hydrogenation in heterogeneous catalysis. The second PhD will concentrate on developing new capabilities for studying heterogeneous catalysts by combining

NMR and vibrational spectroscopy, such as Raman or infra-red, to provide extra information not easily understood using each technique alone. The aim is to be able to gather complementary information from the techniques, and shed further light on many aspects of mechanisms in heterogeneous catalytic reactions.

Johnson Matthey is a specialty chemicals company with a history going back to 1817, when Percival Norton Johnson established a business as a gold assayer. The group is organised into three global divisions: Environmental Technologies, Precious Metal Products and Fine Chemicals. The companies main interests focus on the core business areas, principally the manufacture of advanced materials and catalysts for a wide array of end-uses, including vehicle exhaust after-treatment, fuel cell components, and process industries as well as fine chemicals and active pharmaceutical ingredients and the marketing, refining, and fabrication of precious metals. With operations in over 30 countries, and a wide range of business opportunities, Johnson Matthey is always on the look out for talented scientists and engineers to work with a wide range of advanced technology industries. For more information on Johnson Matthey please visit www.matthey.com



Catalysts manufactured by Johnson Matthey

Emeritus Professor John Davidson on his recent Prince Philip Medal Award



In June of this year, Professor Davidson was presented the Prince Philip Medal in recognition of the miraculous contribution he has made to the Chemical Engineering community throughout his career. The following few words are from the speech he made at the host commemoration dinner on 23 August at Jesus College, Cambridge.

Many years ago, I was told that dons climb the academic ladder on the shoulders of their research students; how true that is. I started well with John Cullen, my first research student. He was an excellent PhD candidate, but he had other qualities, exemplified by a story told by Margaret Sansom. After graduating from Cambridge, John wanted to go on a Master's Course in the USA and applied for an American scholarship. The adjudicating committee was a small group of ladies, the wives of officers from a US Air Force base. The question arose as to where to have the interview. John took them on the river, and got his scholarship. So it didn't surprise me when, many years later, John became Chairman of the Health & Safety Commission and Sir John. Oddly enough, he was, for a time, the boss of my daughter Isabel when she was a lawyer at HSE. It is nice to see her here this evening and also Peter (Prof. Davidson's son), who established the contact with Tioxide, still active. But long ago I realised that Peter and I have different priorities. He wrote a conference paper for ICI: "Look at this, Father". After reading the draft I said, "Couldn't you give a bit more information, eg put some numbers on the diagrams?" Answer: "That would be giving the game away". But I have had many valuable discussions with Peter, though we get into trouble with the distaff side when chemical engineering intrudes at meal times. Mentioning the distaff side brings me to Jane Austen writing about Admiral Croft and his lady driving their gig: the Admiral, of course, held the reins until Mrs Croft exclaimed "My dear admiral, that post! – we shall certainly take that post." But by coolly giving the reins a better direction herself, they happily passed the danger." Susanne, my wife, has taken us past a good many posts during our 62 years together.

I would also like to acknowledge the happy collaboration with members of the staff before and after my retirement. Without them, I could hardly have kept going. Indeed, I feel that the Medal we are celebrating is an award for the Department which has been such a happy place to work in for fifty-eight years.

Professor Alan Hayhurst awarded the Alfred C Egerton Medal



Professor Hayhurst was awarded this medal at the 33rd Beijing Symposium of The Combustion Institute this August, attended by some 1200 people, "for distinguished, continuing and encouraging contributions to the field of combustion".

The biggest honour in the world of combustion is to receive one of the three Gold Medals. Professor Hayhurst added that, "The main thing about this medal is that it's given by an international community not every year, but every other year. Also, it's not a reflection of an individual, but of quite a wide group of people, including research students and postdocs, of course, but also of laboratory technicians, electronics and computing staff, secretaries, administrators, etc, etc. This means that it's a big tribute to the department over quite a period of time; in my case, I first started research in the department in 1964. My role has been to ask other people to do things I cannot do myself, which covers a huge area, so my thanks go to this army of my helpers."

The citation on his medal reads, "For brilliant contributions in several diverse aspects of combustion science, particularly ionisation, pollutants, fluidised bed combustion and chemical looping."

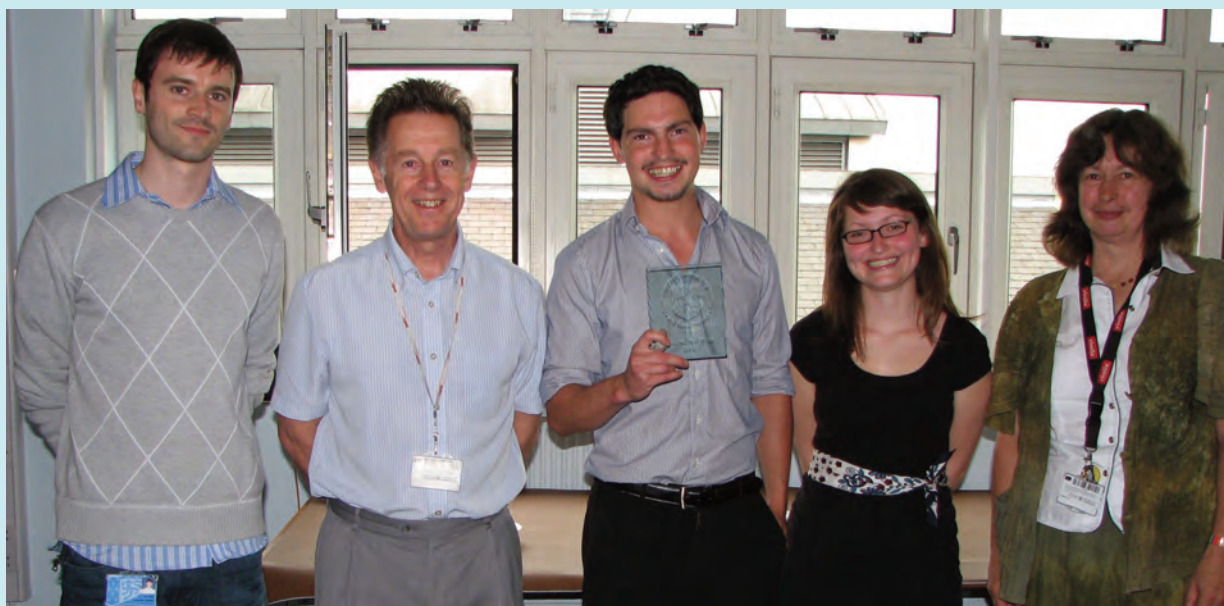
Awards in Biotechnology

In this year's annual Analytical Research Forum (ARF), the premier Analytical Science meeting of the Royal Society of Chemistry, Jakob Mauritz won the best oral presentation prize and Jamie Walters was awarded the poster presentation prize. Jakob is a member of the Laser Analytics Group. He develops modern microscopy techniques for the study of malaria infected red blood cells. His work has helped to resolve a puzzle in malaria research, namely why a red blood cell stays intact for the duration it is held hostage by the deadly falciparum parasite, work that may aid in the design of therapeutic treatments.

Jamie is a member of the Analytical Biotechnology group. His research focuses on the development of 'Ultradots'. These are capsules that provide a quantitative fluorescent signal in response to a particular analyte while also acting as

intelligent delivery vehicles for ultrasound mediated delivery of active (eg drug) compounds.

Soren Demin was the winner of Ronald Belcher Award 2010 for his research in the area of bioelectrochemistry and specifically for his use of the catalytic effect of an enzyme to improve charge transfer rates. Soren Demin is a PhD student at the Department of Chemical Engineering and Biotechnology under the supervision of Professor Lisa Hall in the Analytical Biotechnology group. His PhD research on *Breaking the barrier to fast electrochemistry* is a look at the deeply buried redox site of Glucose Oxidase *in situ* via direct fast electrochemistry. This research is aimed at helping understanding of how biology can be interfaced with electronic components and is applicable in areas of biosensing, photovoltaics and organic computing.



Biotech PhD student seminar winners: 9-10 June 2010

Left to right: Julian Jaros, Prof Chris Lowe, Jamie Walters, Viktoria Steelzhammer, Prof Lisa Hall

A letter from Dr Tony Gillham MBE, Class of 1961

Dear Alumni,

One of my favourite gravestone epigrams is that of a waiter which read *"God finally caught his eye"*. Elena (Prof. Gladden's former PA) firmly caught my eye and asked for a letter to go in **CEB Focus** on matters that might be of interest to readers.

Our American cousins always seem streets ahead of us when it comes to alumni support but congratulations to Cambridge on making huge strides in recent years. These include encouraging you to give lectures covering, amongst other things, help for graduates in making career choices. In February, I gave the second of these in the Department on the heels of Peter Davidson and spoke about how my career took me from ICI Cheshire to MBO of a contract manufacturing company. Questioned about the best starting point for an entrepreneurially-inclined graduate, I plumped for a job in a major (manufacturing) company – before deciding if a move to a smaller company appealed. It would be interesting to hear your thoughts.

Before drafting my script, I talked to members of the Department to find out where their interests

lay. I also spoke to industrialists, including the founder of Ineos, to get different slants on industrial careers. In ICI, my first boss was Robin Paul – a great supporter of our Department – and we celebrated his memory with a dinner in St. Catz after my talk. Profs. Lynn Gladden, Nigel Slater and John Davidson joined us together with Sir David Harrison; the last two were on the staff when I came in 1961. They say that nostalgia is not what it used to be but as I prepared my talk I kept getting reminded of my good friend Prof. Sharma and of our supervisor, the redoubtable, but hugely supportive, Prof. Danckwerts, 'PVD'. I still cannot walk the corridors in the Department without seeing PVD's secretary, Margaret Sansom, disappearing like the White Rabbit round the next corner.

Our American cousins always seem streets ahead of us when it comes to alumni support but congratulations to Cambridge on making huge strides in recent years.

Early this year, I met Peter Varey, who is writing a biography of PVD. Peter kindly showed me a draft chapter from the book for my comments. Peter seems to



have investigated and checked every conceivable source for the biography and it is a considerable feat of scholarship. I even learnt from him that the marks on PVD's face were not war wounds but they certainly added to his aura of Olympian distinction. My own submissions to Peter on PVD struck me on reflection as rather an inadequate tribute to, probably, the greatest chemical engineer of his generation.

By the way, Peter told me about PVD's part in the invasion of Italy: his accident on a beach in the Gulf of Noto. Those of you who knew him may recall he could be somewhat detached at times. Well, after three years of amazing bravery and cool-headed analysis as a bomb safety officer defusing unexploded devices, especially during the Blitz, he woke up on the day after the Sicilian landings and absent-mindedly wandered off down a heavily-defended beach. He trod on an anti-personnel mine and nearly lost a leg: maggots in the wounds saved him. Repatriated in a hospital ship lit up like a

Christmas tree, he was taken off bomb disposal and spent the rest of the war in Combined Operations HQ on Whitehall, helping with technical preparations for the D-Day landings. (If you have any stories about PVD that might be of interest, please contact Peter at petervarey19@gmail.com). I hope the book is soon in the hands of the printers.

My own submissions to Peter on PVD struck me on reflection as rather an inadequate tribute to, probably, the greatest chemical engineer of his generation.

I went to Birmingham in July to attend a Cathedrals Conference. One of my life's little ironies is that, in running a chemical company, I was constantly fighting planners to get approval to build a new plant. One case was only resolved by an article by Christopher Booker in *'The Sunday Telegraph'* followed by a meeting called and attended by the Secretary of State for the Environment. However, I now find myself chairing the planning (and advisory) committee of York Minster. This has brought me close to the teams of craftsmen and women working on stone and stained glass. We are currently engaged in a £20m

project to restore the Great East Window, completed around 1405, and incorporating an expanse of stained glass that is one of the glories of European medieval art. At this Conference, I renewed acquaintance with Sir Hugh Beach (distinguished soldier, engineer, iconoclast and Fellow of Peterhouse) who is my opposite number at Winchester Cathedral. He was my Commanding Officer when I was in the Cambridge University Officers' Training Corps in Grange Road.

Running a chemical factory nowadays demands close and friendly links with your neighbours. This, in turn, leads to invitations to sit on Boards of School Governors and the like. I have found myself for the last 20 years or so on Teesside helping to run a crime prevention partnership. Working closely with the Police, Probation, Local Authorities and others, we employ about 60 people and have enough funds to last until March 2011. In the following financial year, we peer into a financial abyss and I hope and pray that our income survives after the nuclear storm that is currently blowing through our funders. One of our projects involves conversion of large old buses into mobile youth clubs cum media centres. These conversions cost about £60,000 but we are then left with a mobile centre that can be driven to estates in Teesside and used by

youngsters who might never darken the door of a conventional youth club. They are very popular and we often find a queue already formed when the bus arrives. One of our buses is shortly to be pensioned off and I hear that a Motor Museum in Blackpool wants it.

Running a chemical factory nowadays demands close and friendly links with your neighbours.

One evening last week, my wife and I went with our local GP to watch and hear nightjars a mile or so from where we live. We watched two of these mysterious birds fossicking above the bracken fronds in the twilight. Then, suddenly, one was twisting in the air above our heads, chasing a ghostly moth, before it disappeared. The next evening, we were at the start of Ryedale Festival: a feast of music in fine locations like Ampleforth Abbey and Castle Howard. All of this, including nightjars, within an easy drive of industrial Teesside.

I hope that something I have written might have caught your eye – perhaps even as firmly as Elena caught my eye in getting me to write this letter!

Dr Tony Gillham
gillham321@tiscali.co.uk

University of Cambridge Chemical Engineering and Biotechnology (CUCEB) Alumni are now connected!

The following online platforms have been created to help our alumni connect with fellow alumni and department members on a professional and social level and to help us organise events and activities of relevance.



CUCEB Alumni on LinkedIn

Department alumni are encouraged to join this on-line community to help them make new valuable career contacts as well as be kept abreast of CEB's latest developments. Many of our alumni are industrialists or researchers, who are willing to share their expertise. Alumni can ask for advice on recruitment matters and browse relevant vacancies posted.

Elena Gonzalez, PA to Professor Nigel Slater (HoD), is the Group Manager, see her profile on www.linkedin.com/in/elenagonzalezcuadrado



Left: Elena Gonzalez with recent department alumni



CUCEB Alumni on Facebook

This newly-created group will also help you connect with fellow alumni. It is more geared to those who are up for connecting on the social as well as professional level. This will also help us organise alumni reunions, speaker series, etc as well as develop an Alumni Relations Events Programme more suited to their needs.



Twitter @CUCEBAlumni

We would like to share important department developments on teaching and research, our people and their achievements as they happen. Alumni's views on our undertakings are extremely valuable to us. Therefore, CEB is using this tool to allow them to post comments on the news we share, give feedback on our progress and make relevant questions. Elena will also be monitoring comments/content and posting replies on behalf of the department.

'Alumni Corner' column on 'CEB Focus' Department Newsletter

We would very much appreciate suggestions for topics, letters, anecdotes from your time in the Department and/or College, career profiles and important announcements you might want us to make on your behalf. Please contact the **CEB Focus** Editorial Team on ceb-focus@ceb.cam.ac.uk with your contributions.

Alumni Speaker Series Launch

Friday 29 October 2010, 5.00pm

Location: CEB, Pembroke Street

Alumnus Chris Hodrien will be launching the series this academic year with a talk on '*A Lifetime in the Gas Industry Technology*'. He will also be giving an account of his successful career in this field.

If you would like to attend please register on www.ceb.cam.ac.uk/pages/alumni-speaker-series.html by Thursday 28 October or contact Elena Gonzalez on alumni@ceb.cam.ac.uk

The 4th annual EBI-Sanger Cambridge PhD Symposium

1 November 2010

Location: Wellcome Trust Conference Centre, Hinxton, Cambridge. www.escamps.org

This is a unique student-led conference aiming to encourage scientific communication within the local research community. The focus of this one-day event is to provide a platform for young scientists to present their work. The meeting will also include keynote presentations by established scientific leaders. All students from the University of Cambridge are invited to register for this free event. It is our hope that eSCAMPS 2010 will continue to achieve its aims of stimulating scientific discussions and fostering networking within the Cambridge graduate community. We look forward to welcoming you here!

Professional Development Policy Seminar organised by Centre for Science and Policy (CSaP)

15 November 2010, 10.30am - 4.30pm

Venue: The Pitt Building, Cambridge

The research community is making increasing efforts to maximise the impact of its expertise in public policy. All the global and national challenges we face rely - and arguably should rely more - on advice from experts in the sciences, social sciences and engineering. It is now widely acknowledged that policy makers should be open to advice from researchers, and researchers should be well equipped to deliver that advice.

Shell Careers

Wednesday 13 October 2010

Whether you're studying for a BA, MA or advanced degree, or even if you've already graduated, Shell can offer you a wealth of challenging career opportunities. To find out more about our current opportunities, please visit our website

(www.shell.co.uk/careers). You can also follow us on Facebook at '*Careers at Shell*'. Shell will be at Cambridge during Michaelmas term so look out for our events and come along to meet our people.



Shell Presentation @ University Arms Hotel, Parker's Piece, Cambridge – check careers service calendar for full details.

Dr Binjie Hu Teaching Fellow

I joined the department on September 2007 to undertake a wide range of undergraduate teaching for Part I and IIA exercises and the Part IIA design project. I have also been involved with design lectures, transferable skills and laboratory-based teaching. During my time at Cambridge, I developed a very strong teaching experience over many chemical engineering subjects.



I am leaving Cambridge to work as a lecturer in the Division of Engineering at the University of Nottingham Ningbo, China (UNNC). In the past, my research was on hydrogenation in catalytic three-phase (hydrogen/organic/catalyst) reactions, the stability of bubbles in two-phase systems, and membrane separations. In future, I will be studying green chemistry applications using ionic liquids. I look forward to establishing a research group in China and forming future collaborations with Cambridge.

David White PhD student

I joined the department on October 2005 to undertake research in the area of food manufacture with funding from CASE and EPSRC.

My research was based on the production of Marmite: a foodstuff that is marketed primarily in the UK and manufactured from spent brewing yeast. Specifically, I studied one of the intermediate unit operations and the rheology of the final product. The findings will be used to aid design and process decisions, and have also spawned interest in a future project with the department. Aside from research, I spent two years as head coach of the University Lightweight rowing squad, winning two Boat Races against Oxford. I am now working for Cadbury/Kraft Foods in Bournville.



Summer Departures Gone on to pastures new

Dr Tim Lord, Dr Yishai Levin and Dr Yagnesh Umrana – Research Associates

Miss Sarah Creber, Miss Ria Kouprotzi, Mr Thomas Pintelon, Mr Joel Taylor, Mr Ed White – PhD students

Dr Juan Manuel Peralta and Dr Barbara Meza – Visiting Researchers

Prof Catherine Niu – Visiting Professor

Miss Ghalia Feddah – Visiting Research Student

Mrs Cassilda Reis – Lab Technician

Lucy Thompson – Receptionist
Jessica Deacon –

Accounts/Secretarial Assistant

Miss Christin Oheim – Junior Research Lab Technician

Miss Patricia Tynan – Temp Receptionist

Summer Arrivals

A warm welcome to:

Prof Esther Lubzens and Prof Guang Li – Visiting Professors

Dr Johann Steiner – Visiting Researcher

Dr Einer Fridjonsson, Dr Tatsuya Yoshimi, Dr Matthew Watson and Dr Natacha Vanattou-Saifoudine - Research Associates

Miss Meral Yuce, Mr Andreas Albrecht, Mr David Pereira and Mr Adriano Zaffora -

Visiting Research Students

How to Make the Dunk a Sure Thing

Alastair Clarke, PhD Student

Cambridge chemical engineers are machines that turn tea into concepts. A prime example was the well-oiled Professor Danckwerts, who came up with residence time distributions whilst indolently pondering over a good brew in the department tea-room. In fact, the tea-room lends itself to demonstrating all sorts of chemical engineering principles. In this issue of **CEB Focus**, we look at the problem of dunking biscuits into tea. We ask for how long should you dunk before it is too late - the biscuit becomes saturated with tea and breaks in two?

A biscuit consists of a random structure of irregularly-sized pores which cause the tea to be sucked into the biscuit by capillary forces. The biscuit dunking time (t) will scale with the square of the distance travelled (L) divided by the conductivity (α) ie $t = L^2 / \alpha$. The exact relationship is given by the Washburn equation¹. Conductivity depends on a number of physical properties, including the mean pore-size (d), the surface tension between air and tea (σ) and the viscosity of tea (μ).

The exact relationship² is expressed as

$$\alpha = \sigma d / 4\mu$$

Biscuit has similar properties to sandstone, which has a mean pore-size of roughly 1 μm . Tea is mainly water. The surface tension between air and water is 0.07 kg s^{-2} and the viscosity of water is 10⁻³ $\text{kg m}^{-1} \text{s}^{-1}$. The biscuit has a thin disk shape and is dipped vertically into the tea. Surface and gravity effects are neglected.

If the thickness of the biscuit ($2L$) is taken to be 1 cm, the Washburn equation advises to dunk for no longer than 1.5 seconds. Is this a sensible answer for Ginger Nuts or Hob-Nobs? It seems right for the Rich Tea, but it worryingly underestimates the Shortbread Finger.

References

¹Dullien, F.A.L, 1979. Porous Media: Fluid Transport and Pore Structure. Chapter 6. pp. 291-300. Academic Press Inc., San Diego, USA.

²Fisher, L., 2003. How to Dunk a Doughnut: The Science of Everyday Life. Arcade Publishing.

Letters to the editor

We welcome comments from our readership. Please email us your views and suggestions for future articles on ceb-focus@ceb.cam.ac.uk

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For further information please visit www.ceb.cam.ac.uk or contact us at emailus@ceb.cam.ac.uk