

# CEB *Focus*

Department of Chemical Engineering and Biotechnology



## In this issue

Message from HoD	2
Editorial	2
Front Cover Article	3
Undergraduate Focus	5
Graduate Hub	6
Teaching Matters	7
Research Highlights	11
Research Feature	13
Departments Events	15
Industry Business	16
Alumni Corner	17
Staff Room	19
Arrivals and Departures	21
Dear Dr Sarah	22
Tea-Time Teaser	23

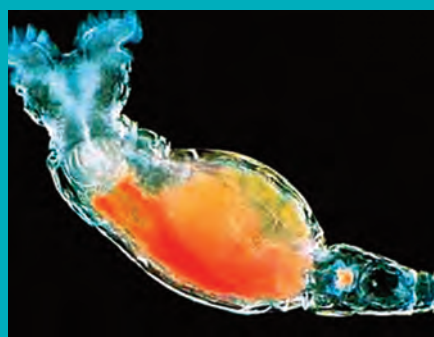
*BUCT Summer School takes over CEB p.3*



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ChemEng Tripos Explained

p.7



Astrobiology: Science Fiction or  
Next Frontier

p.11



NEW! Staff Room

p.19

## Message from HoD Professor Nigel Slater



The summer months are usually quiet for academics in Cambridge as students leave and the city fills up with tourists more intent on exploring the colleges. For CEB these months have seen much activity as the New Building project received 'green light' status and the process of designing, building and paying for this landmark project moved into top gear. The University released the first tranche of funding, which is to be used for the detailed design of the building. Numerous companies tendered for this prestigious project, from which the Architects, Project Managers, Structural and Civil consultants and M&E consultants have been appointed. CEB will now engage closely with these professionals to ensure that our needs and aspirations, now and for the foreseeable future, are realised within the final designs. This process is critical if, as we hope, the new building is to provide an environment that connects and intensifies CEB's academic and commercial activities to exploit their potential to the full, creating a new training and research-to-exploitation hub that will:

- enhance the student learning environment in ways that integrate modern e-learning methods with traditional lecture and informal classroom techniques;

- provide an environment in which new research ideas that cut across traditional discipline boundaries can be nurtured, and where scientists are encouraged to work together on imaginative new concepts;
- provide state-of-the-art facilities to attract the best staff and students from across the world;
- establish space in which teams with innovative new concepts for business innovation can incubate their ideas in a safe and nurturing environment prior to spin-out;
- provide the department with long term flexibility to respond to an evolving research programme in response to evolving global challenges.

But this all comes at a cost, which two stages of conceptual design and validation have indicated to be in the region of £57M. To reduce the drain on University capital CEB has been working closely with the Cambridge University Development Office (CUDO) and a group of advisors from amongst our alumni to develop a fundraising strategy. This process is well advanced and further details will be announced later in the year.

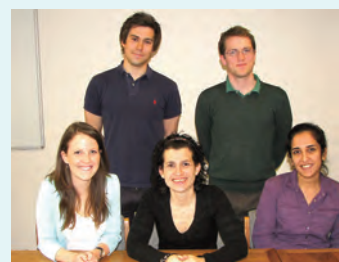
While walking through Islington with my family recently I was struck by an unattributed quotation in an empty shop window, which read '*The best way to achieve something is to begin*'. Well, I can report that CEB has begun the New Building with completion planned for Autumn 2015.

## Notes from the Editorial Team

The *CEB Focus* Editorial Team is led by Elena Gonzalez who is assisted by fellow editors Alastair Clarke, Marijke Fagan and Nick Ramskill. We wish to thank Rashmi Tripathi, who is leaving the team as her studies come to an end. We are also grateful to Vanessa Blake and Barrie Goddard for their photography.

Over the summer, the Editorial Team with our Designer, Paul Walford revamped *CEB Focus*. The front cover has been re-designed, typeface altered and a new section named 'Staff Room' added, which will provide news on all members of staff, both academic and non-academic. The old 'Postgrad/Postdoc Hub' has now been replaced by 'Graduate Hub'. We hope that the new look of *CEB Focus* will appeal to its readers.

*CEB Focus* is an opportunity for you to support and enhance the CEB community at Cambridge. Contributions from department members, alumni and corporate partners are always welcome. Please send us your comments or suggestions for articles to [ceb-focus@ceb.cam.ac.uk](mailto:ceb-focus@ceb.cam.ac.uk). If you wish to receive a regular e-copy of *CEB Focus* please subscribe by sending a message to [ceb-news-request@lists.cam.ac.uk](mailto:ceb-news-request@lists.cam.ac.uk) with 'Subscribe' as the subject of the message. We look forward to hearing from you in the future!



Editorial Team: From left to right Marijke Fagan, Elena Gonzalez and Rashmi Tripathi; back row: Nick Ramskill and Alastair Clarke

## BUCT Summer School takes over CEB



For the second consecutive time a group of students from Beijing University of Chemical Technology (BUCT) attended a two week Cambridge-BUCT 2011 Summer Academics and

Students Visiting Program. July saw the arrival of 30 visitors from BUCT for the annual BUCT-Department Summer School. The delegation included 27 undergraduate students studying courses in science and engineering at BUCT. The Summer School programme gave students a broad range of information about living and studying abroad for a PhD. During their stay the students visited colleges, science and engineering departments and received a selection of lectures from University staff and industrialists. The course also gave students the chance to network with groups and people already studying in Cambridge through a series of social events.

BUCT is one of China's key institutions of higher learning affiliated to the Ministry of Education and is a comprehensive university with a core curriculum of science, engineering, economic management, language and other liberal arts. It has a wide focus on national education and scientific research and plays an important role in the development of the national economy. BUCT is dedicated to establishing long term collaboration/cooperation with other universities and organisations in China and abroad; it aims to become one of the top level universities in the world.

In 2009, a group of academic delegates led by vice president Prof Biaohua Chen visited CEB and met with many members of the department. A long term comprehensive and constructive collaboration started back then culminating with an MoU signing between the Universities this June.

Since 2009 both parties have gained a mutual understanding of culture, education, research and student experience within the two institutions. This year's summer visiting program again focused on

cultivating research interests, and gaining experience and expertise. On the last day BUCT students presented their design projects to Dr Adrian Fisher and Dr Kamram Yunus, CEB academics and BUCT Summer School organisers.

BUCT academic Dr Yuan Pu commented "You have arranged a fantastic BUCT-Cambridge Summer School. I was very impressed by the subjects and all the other activities organised. Almost every student told me they had a very good experience. We really hope it will be even better next year!"

BUCT students told the Focus Team about their experience of the CEB-BUCT Summer School and Cambridge city:

Hongkai Ma, a Biological Engineering student from Beijing College of Life Sciences and Technology commented "I am impressed by the hospitality of faculties and also the students as well as Dr Fisher, Dr Gu and also senior Zeng. Cambridge is a very small, beautiful and peaceful place, it differs greatly from Beijing, a big capital city with a large population." She added "Cambridge is a better place to live and study though I have to admit that I prefer Chinese cuisine! It is different from what I had imagined. All I knew is that Cambridge is a top university in the world. But after spending two weeks there, it became much more than a far-off, cold name because of the beautiful colleges, great history, helpful teachers and energetic students."

Yuan Li is a student from Hefei City in the Anhui Province with a degree in Biological Engineering. She expects that the Summer School will also get better overtime by increasing the level of lectures as "the current syllabus seems a little easy at times." However, she admits she did "learn a lot whilst in CEB and particularly enjoyed the lab tour in the biotechnology site." Yuan Li explained "The tour was not part of the plan but Dr Yunus arranged this for me as I had previously expressed my wish to further my studies in the area of cancer biology. The tour was really impressive and I am very grateful to Dr Yunus, Professor Lisa Hall, who allowed me to look around in





BUCT students presenting Elena Gonzalez (PA to Professor Slater) with a painting of a Lotus Flower by talented BUCT student Wei. From left to right Wei Xiaoxiao, Luo Zhuohui, Guan Zhong, Gao Simiao, Yuan Li

her labs, as well as PhD Student, Jamie Walters, who took his time to explain the research undertaken there.”

“I spent most time listening to lectures and seminars presented by teachers from Cambridge and other well-known universities getting to know more about the department and its current research. I also took part in a very challenging case study. Our college focuses more on research of industrial scale doing much work with factor control in manufacture and purification of products. Some CEB researchers are doing similar work with cell biology and molecular biology and nanoparticles but at a smaller scale. I have never experienced this before but it really felt that CEB is really doing something that will somehow change the future of our daily life” says Yuan.

T. Zhong Guan, from Henan province in central China, added “The best moment for me was the presentation of our case study on the last day. I learnt a lot about the nano-particle science and marketing analysis.”

Wei Xiaoxiao, another BUCT environmental engineering graduate also thoroughly enjoyed the Summer School’s curriculum as well as “eating fish and chips, looking at the typical British red mailbox and buses, walking around the streets, punting on the river

Cam.” She added “Cambridge was better than I imagined. The lab experiment was very enjoyable. I noted that Health and Safety in labs is hugely important in the UK with more standard safety measures to follow here than in China.” After the summer Wei will be preparing for the Graduate Record Examination and continue with her studies.

*“I have never experienced this before but it really felt that CEB is really doing something that will somehow change the future of our daily life”*



Summer School organiser Dr Kam Yunus summed up the experience “This year the CEB Summer School once again was a real success, and was well received both by the BUCT delegates and members in the department. We found the course had gained much momentum and was being reviewed as a long term strategic event between BUCT-Cambridge. It is anticipated that the Summer School will continue to provide a great porthole for outreach activities with leading academic institutes in the East and Southeast Asian subcontinent.”

CEB is also expected to be accommodating a larger number of BUCT students at future Summer Schools.

### Welcome from CUCES Committee



CUCES is a student run committee and our purpose is to be there for Chem Eng students. We have a long tradition of organising great careers and social events for all Chem Engers and it is a pleasure to serve such an academic yet sociable department. We really enjoy working as part of one of the best performing (ranked 5<sup>th</sup> in the UK for 2010/11) and friendliest societies around, so let the excitement continue!

Don't forget to check out our website regularly to stay informed with the latest news and happenings. If you have any suggestions, ideas or questions, don't hesitate to get in touch. Stay tuned with CUCES at [www.srcf.ucam.org/cuces](http://www.srcf.ucam.org/cuces)

### Undergraduate Summer Internship Highlights

Over the summer vacation some of the undergraduates have completed internships and two students have shared their experience with us.

#### Worsley Parsons, Laurence Tonna (Part 1)

During the period July/August '11, I had the fortune to undertake an internship in the process engineering department of Worley Parsons, a global engineering service contractor, in Muscat, the capital of the Sultanate of Oman. The placement involved me following a selection of modules from their graduate training scheme, and through a series of mentors I was given a grounding in what is essentially Oil and Gas 101: from its exploration and production, to treatment and refining.

It was very interesting to note the difference between being a practicing process engineer, and a very theory-

conscious student. Rest assured, you won't be writing many integral signs as part of your jobs! The 'science' of it all is, without doubt, crucial, but being in the professional workplace certainly put the theoretical courses into perspective!

Being abroad, in particular being in a very culturally-different, oil-dominated part of the world, offered a tremendous insight into what global chemical engineering is all about: everything from driving on the other side of the road, to picking up the odd Arabic phrase in the office, to jet-skiing past coastal plants all made for a fantastic experience.



*Laurence enjoying some downtime during his placement in Muscat.*

#### Exxon Mobil, Carl Tilbury (Part 2A)

Exxon's summer vacation course is extremely well organised. They go out of their way to help Cambridge students apply by fast tracking you through the interview process and coming to Cambridge to interview you. Once you get to Fawley, this continues in the breadth of the activities they organise such as free dinners and bowling nights to name a few.

You get exposure to the largest oil refinery in the UK and you will get real work to do that has tangible economic or safety benefits. The size of the course (16 students in 2011) is great for eight weeks and you all live together in halls, which is great for getting to know everyone. On top of that, you've got a social budget to organise events (we did go-karting, bowling, camping trip to the Isle of Wight, Thorpe Park and BBQs) and an end of internship black tie ball. This is a highly mature internship - I met someone who did it in '76 - and the result is a finely tuned course that is pitched at exactly the right level to give you an incredible summer and an unparalleled insight into the industry.



## Manny's Three Peaks Challenge Fundraising Campaign

Immanuel (Manny) Kemp gained his BA and MEng with us and stayed on at the department to study for a PhD with Dr Dennis, working on Fischer Tropsch reactions. The last issue of *CEB Focus* featured an article on Manny's preparation and fundraising for the Three Peaks Challenge which he has now completed this past June for a paediatric cancer charity called KidsCan ([www.kidscan.org.uk](http://www.kidscan.org.uk)).



Manny (second from right) with his fellow climbers on the top of Ben Nevis

The challenge involved climbing to the tops of Ben Nevis, Scafell Pike and Mount Snowdon, the highest peaks in Scotland, England and Wales respectively, in only 15 hours of climbing, commencing in the mid-afternoon on June 18<sup>th</sup>. The group managed this in 15 and a half hours because of bad weather and poor visibility on Scafell Pike. The total distance covered on foot was about 26 miles. The challenge would normally be conducted with a 24 hour time limit including driving between the Peaks, but the organisers opted to time the actual climbing and not the driving as teams in previous years have been known to ignore the speed limit on the M6 when the clock was running.

Manny has so far collected £2120 and it is not too late to donate via his Just Giving page at [www.justgiving.com/kidscan-manny-threepeaks](http://www.justgiving.com/kidscan-manny-threepeaks) or by a cheque payable to A. I. Kemp to his pigeonhole.

## Amy Chesterton's Media Fellowship

Amy Chesterton has taken time-out from her PhD this summer to become a Media Fellow at the Naked Scientists. She describes what she's up to ...

The British Science Association is a charity which aims to advance the public understanding of science. Each year they organise Media Fellowships to allow practising scientists to gain experience of working in the media. The aim is to give scientists a better understanding of how the media works, leaving them better equipped for positive experiences in the future while improving scientist-journalist relations. This year there were 10 media fellows, from universities and research institutes across the UK. Placements included newspapers, such as *The Guardian*, online news, such as the BBC, and radio, such as my placement at the Naked Scientists. The Naked Scientists are a group of media-savvy scientists who promote science to the general public. They do this through many media outlets, including online podcasts, online news and kitchen science experiments to try at home. A weekly radio show also broadcasts from BBC Cambridgeshire across the south east of England.

My placement lasted six weeks where I learnt the embargo system, wrote news articles, interviewed scientists and edited audio into podcasts. The climax of my placement was the British Science Association science festival in Bradford in September. The event comprised of two sides: science outreach for the public and science news conferences for the media.

Along with the other fellows, I had 'access all areas' to the press rooms, organised conferences and embargoed news. My job was to source the most news-worthy stories, and gain recorded interviews and contact details for my return. My final responsibility was to produce my own radio show which aired from the BBC studios across the South East on the 25<sup>th</sup> September.



Amy in BBC studio booth

## ChemEng Tripos Explained

Dr David Scott

Director of Teaching

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Dr David Scott (back row far right) at Pilkington Teaching Prize Awards Ceremony hosted by University Vice Chancellor Professor Sir Leszek Borysiewicz

The aim of the Chemical Engineering Tripos is to prepare our students for a professional lifetime of technical activity. One of the strengths of the course - recognised by many outsiders - is the emphasis on fundamental principles, and one of the learning outcomes we wish to achieve is an ability to use the fundamentals of physics, chemistry and biology, together with mathematics, to solve new problems in the discipline, and to find new solutions to old problems. Skills in the fundamentals are complemented by activities in design and engineering practice.

The course has a flexible first year, with the Natural Sciences route being ideal for those who like pure science and want to understand how things work at a fundamental level, and the Engineering route giving a broad background and an emphasis on applying science to real-world problems. In years two and three, students are taught the core topics of Chemical Engineering and are introduced to Biotechnology. They are taken to professional level in well-established areas of the discipline, giving them the knowledge and skills to deal with many problems in modern process industries. At the end of year three, students undertake a project on the design of a modern industrial process.

This design project brings together much of the material they have been taught, while giving them the opportunity to work in teams on an open-ended problem to which there is no single 'right' answer. In many ways, it is the design project that transforms them from students into people capable of practising engineering.

*"We work to make our students understand material and to think for themselves."*

In year four, students are exposed to Master's Level material at or near the leading edge of Chemical Engineering and Biotechnology research. This includes optional modules proposed by lecturers, allowing academic staff to communicate their enthusiasm for their research interests. A hallmark of our course is that students gain experience of real research in the final-year research projects. This is genuine research - running for longer than in most other universities - and it is not uncommon for students to become authors of papers in leading international journals.

We work to make our students understand material and to think for themselves, rather than just following recipes. We do this not just by setting challenging problem sheets and exam questions, but also by setting assessed coursework (exercises). Cambridge College supervision system enables us to put students on the spot and test their ability. Emphasis on understanding and thinking is becoming increasingly important in this age of instant electronic information.

Great support staff (IT, laboratories, workshops, secretarial, administration, tea room and domestic) and members of the research school assist us with demonstrating and teaching. We must also thank our many talented students, who question us, point out our errors, and come up with new solutions (and also problems). This improves our understanding and helps us to develop the course.

## Farewell to MBEs 2011

*Dr Linda Allan*  
*MBE Director*

The Master's in Bioscience Enterprise students' year concluded in style with two events: a formal Symposium was held at The Nucleus, Chesterford Research Park, during which the students presented their research findings to an audience including the University's Examiners and business executives responsible for hosting students during the company internship component of the course. Professor Graham Richards, Emeritus Professor of Chemistry from Oxford, together with Professor Chris Lowe, Director of the Institute of Biotechnology, provided the students with a plethora of stiff questions on a diversity of internship topics, ranging from the commercialisation of adjuvants for stem cell delivery to the healthcare value chain for the medical device industry in China.

A quick change into party mode was then called for, especially by the five students whose day was enhanced by a call for a *viva voce* in the late afternoon. The transition is one that apparently has been practiced frequently by the students during the year and went without a hitch, leaving plenty of time for socialising at the celebratory Farewell Dinner later in the evening. The guests who joined the festivities at Jesus College included many of the programme tutors and mentors from academia and industry. The event was an opportunity to thank these contributors as well as to bid farewell to the students.

Guest of Honour Mark Trusheim, Executive in Residence & Visiting Scientist at MIT, generously made the second of two journeys from the USA this year to speak to the current 'MBEs'. Earlier in the year Mark lectured together with Dr Eddie Blair on the theme of current initiatives and opportunities for business in the personalised and stratified medicine space. At the dinner Mark reflected more personally on insights gained in founding and developing several successful life science companies in the USA, whilst offering sound advice on taking life's inevitable disappointments with courage and good humour.

He acknowledged having the good fortune to have access to education, which struck a sound note with the

members of the department concerned with raising funds for bursaries to enable students of all backgrounds to study here in the future. We extend our sincere thanks to Mark for making a generous allocation of time and expertise available to the students. Also to the two technology companies who financially supported the dinner, Pharming and IML Ltd., and recruitment company RSA, for the donation of an award for excellence in the dissertation aspect of the course.

*"Since formally graduating in July the students have journeyed far and wide across the globe, some back to their own countries, others to take up business and academic roles in entirely new geographies."*



*Despite modestly resisting, Professor Chris Lowe was eventually prevailed upon to display his recently awarded OBE to members of the MBE class during the Symposium.*

Since formally graduating in July the students have journeyed far and wide across the globe, some back to their own countries, others to take up business and academic roles in entirely new geographies. Happily most of 2010-11 MBEs have already secured positions and we wish them every success in these engagements.



## Three New Lecturers on Board

*Michaelmas Term 2011 welcomes three new academics*

### Professor Sabine Bahn



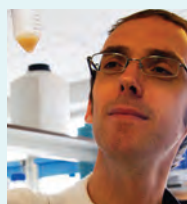
Professor Bahn is a practising clinician (she holds an Honorary Consultant

position in General Adult Psychiatry at Addenbrookes Hospital, Cambridge); she is also a leading research scientist, Director of the Cambridge Centre for Neuropsychiatric Research at Cambridge University and a fellow of Lucy Cavendish College. Her main research interests are to understand the molecular basis of neuropsychiatric/neurodevelopmental disorders, with a focus on the major psychotic disorders, schizophrenia and bipolar disorder. Professor Bahn has published numerous articles in high impact journals over the last years.

She is dedicated to translating her research into clinical practice to the benefit of patients. To this end, in 2005 she co-founded Psynova Neurotech Ltd., which, together with Rules Based Medicine has launched the first blood test aiding in the early diagnosis of Schizophrenia.

Among several of her achievements in 2010 she was appointed Professor for Translational Neuroscience at Erasmus University Medical Centre, Department of Neuroscience, Rotterdam. In February 2011 Psynova Neurotech and S. Bahn were announced winner of the ACES best European Life Science spin-out award.

### Dr Graham Christie



Dr Christie's academic background is very much in the field of microbiology and

biotechnology, having studied for a BSc in Microbiology at the University of Strathclyde. This was followed by a PhD at the University of Warwick, during which he conducted research relating to the real-time monitoring of the physiological status of micro-organisms in various fermentation processes. After a period working in industry, which included a spell as the Deputy Section Head of Microbiology at Rank Hovis McDougall Technology, Dr Christie joined Professor Chris Lowe's group at the former Institute of Biotechnology. Initial work on the development of holographic-based sensors for the detection of bacterial spores led to the initiation of a program of research aimed at elucidating fundamental aspects of the spore germination process. This, and other areas of spore-related research – the outputs of which could lead to applications within the healthcare and food manufacturing sectors – continues to form the focus for research conducted by Dr Christie's group within the Department of Chemical Engineering and Biotechnology.

### Dr Daniel Holland



Dr Holland has been appointed as a University Lecturer in Sustainable Reaction

Engineering. Daniel graduated from the University of Canterbury, New Zealand, with a B.Eng(Hons). After a brief period working at Industrial Research Ltd, he came to Cambridge where he studied protein chromatography using magnetic resonance. After his PhD, he continued to work in the Magnetic Resonance Research Centre on the development of new magnetic resonance (MR) techniques to study complex multiphase flows, in particular pioneering dynamic studies of gas-solid flows. He then began to explore how signal processing can be used to dramatically improve MR measurements. This research has led to at least an order of magnitude reduction in the acquisition time and spatial resolution of MR measurements, therefore enabling the use of cheap, portable MR systems. He is now exploring how these ideas can be applied to electron tomography, electrical capacitance tomography and NMR spectroscopy. The new capabilities that these techniques provide will be used to provide detailed measurements of multiphase flows to aid the development of numerical modelling techniques and ultimately to design more sustainable and efficient processes.

## Design Project 2011

*Dr Bart Hallmark*

*CEB Lecturer*

This year's CET IIA design project was based around the scenario of retrofitting a carbon capture unit to a gas fired power station; the hypothetical location of the unit was at the Saltend chemical park due to Humberside having been designated a UK carbon hub. The project was generously supported by Jacobs and Aker Clean Carbon, who provided valuable technical input to both staff and students and a prize fund for the best design. Once the project was completed, Jacobs was also able to make internship offers to two of the best-performing students.

The project started with a one-day workshop, an 'industry day', which was given by representatives from the British Chemical Engineering Contractors Association (BCECA). A class of 46 students were reminded of the key stages of the design process, spanning bidding to commissioning, in the context of a cryogenic separation unit. It was felt that this was a useful exercise to remind everyone of the open-ended nature of design since the start of the project fell only three days after the end of the CET IIA Tripos exams.

The class of 46 students was divided into eight teams, which were organised to satisfy the constraints of educational background (natural sciences or general engineering), CET I results and gender. Each team then

had five weeks to produce a complete plant design report, which had to include a full technical design for the plant and its control systems, a safety, health and environmental appraisal, an economic analysis and initial plot layout drawings.

Once the final plant design report had been submitted, the student teams then had to present their findings to a panel of judges, which comprised the academic staff design team and external guests. In addition to Ian Salmon, representing Aker Clean Carbon and Jacobs, representatives from the East Anglian branch of IChemE along with staff from local engineering companies kindly gave their time to appraise the students' work. The presentation winners were group 'G'. The departmental design prize, awarded for the best individual performance, was shared between Alexander Smith and Carl Tilbury.

Speaking after the event, Ian Salmon said that he was very impressed with the technical quality of the results from all of the student groups along with the high standard of the presentations. This feeling was shared by Alan Stanford, secretary of the East Anglian branch of IChemE, and by Latoja Jack, who was attending on behalf of AVEVA group plc. Professor Slater, HoD, was delighted with Jacob's offers of student internships based on design project performance; hopefully, this route to provide students with industrial experience can be repeated in future projects.



*Ian Salmon (left) from Jacobs Process Ltd with this year's winning design project group. From left to right: Helen Breewood, Calvin Cheung, Alexander Smith, Vinayak Rajendran (Henry Chan absent)*



## Astrobiology: Science Fiction or the Next Frontier?

Rashmi Tripathi

PhD Student, Cell and Organism Engineering

The question of whether we are alone in the Universe has been asked since the dawn of civilisation and inspired great works of science fiction and art. But what is the science behind it? Astrobiology is an interdisciplinary science that investigates the origin and evolution of life in the Universe. It is mainly built on advances made in the areas of astronomy, biology and the physical sciences. Major western governments value research in the field. For example, NASA (National Aeronautical Space Agency, U.S.A) and the ESA (European Space Agency) have launched exo-planet detection programs that aim to identify 'earth-like' planets in other planetary systems by analyzing their atmospheric spectra. Frank Drake famously estimated that there could be 10 communicating civilisations in our own galaxy, the Milky Way. But so far evidence for extra-terrestrial life has been hard to find.

NASA and the Planetary Sciences Unit, at the Open Unit, Milton Keynes have discovered organic material in the Martian meteorite EETA 79001 which was located in the Antarctic, hinting towards the existence of possible biological activity in this extra-terrestrial piece of rock millions of years ago<sup>1</sup>. Potential nanofossils have also been reported in another Martian meteorite ALH84001<sup>2</sup>. Sceptics say that these are probably artefacts rather than evidence for extra-terrestrial life. It is also believed that one might not be able to prove the existence of life until an actual 'cell cavity' is detected.

Recent media coverage of 'astrobiological discoveries' has focused on reporting the existence of organisms in habitats previously thought to be devoid of life on our planet, thereby raising the possibility of detecting life forms on other similarly harsh celestial habitats. Last year NASA reported the existence of microorganisms capable of substituting arsenic in place of phosphates in their DNA and other bio-molecules, thus being able to survive under conditions that were until then believed to be toxic to all life forms<sup>3</sup>. Similarly, the discovery of ecosystems solely powered by energy released by radioactive decay of elements, several kilometres below

the Earth's surface, raises the titillating possibility of hidden life beneath other planetary surfaces<sup>4</sup>.

Currently the attention of astrobiologists is shifting from the discovery of life to the creation of it. With the advent of synthetic biology it is now possible to create organisms with novel capabilities and functions. By engineering the genetic and metabolic circuits in living systems, we might one day be able to devise life forms that could survive in extra-terrestrial habitats. Many earthly organisms already possess this uncanny ability. For example, *Polypedilum vanderplanki* larvae have been sent out to space in their anhydrobiotic state and have remarkably revived after two and a half years, albeit with diminished reproductive capacity<sup>5</sup>. Their next mission will to be Mars! Understanding how anhydrobiotic organisms such as *Polypedilum* and rotifers (Figure 1) *Adineta ricciae* survive in extreme conditions might enable the creation of other space-tolerant life forms. The latter is currently under study in the Cell and Organism Engineering Laboratory in the department.

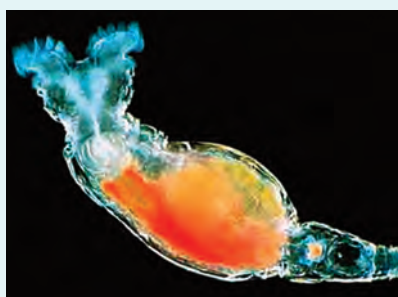


Figure 1. Rotifer image taken from scientific blogs.

Are there any advantages to introducing life on other planets? One might argue that with the human population predicted to burgeon in the next few centuries, conversion of other

planets to a more earth-like state might hold the key to our long-term survival as a species. Plants and other photosynthetic organisms could allow the conversion of water to oxygen in temperature-regulated greenhouses making it possible to build homes on the Moon and Mars! Microorganisms could also be used for bio-leaching of precious minerals and rare elements on these planets. Besides the economic benefits, shaping the evolution of ecosystems on a planetary scale is a

fascinating challenge in its own right. This is an exceedingly rare feat that took place on our planet when bacterial life first evolved roughly 3.8 billion years ago. However, given the enormous cost to space research and development, it remains to be seen how far into the future this might actually happen. Who knows we might one day be able to engineer living organisms to survive anywhere in the Universe (including black holes and quasars!).

**Acknowledgements:** I would like to thank Alastair Clarke for his comments and Dr. Alan Tunnacliffe for his encouragement.

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## Developing Microwave Pyrolysis for Recycling Engine Oil

Su Shiung Lam and Prof Howard A. Chase

Biochemical and Environmental Engineering Group

Used automobile engine oil is an environmentally hazardous waste that is difficult to dispose of due to the presence of undesirable species such as soot, metals, and sulfur compounds. Existing treatment processes such as incineration, combustion, and catalytic hydro-treatment, are becoming increasingly impracticable due to concerns of environmental pollution (with associated toxic emissions and greenhouse gas release) and the difficulties of disposing of the sludge generated by these processes.

The project investigates the feasibility of using microwave heating to generate a pyrolysis process for

recycling and transforming the used oil into valuable hydrocarbon feedstocks. By pyrolysing the used oil in a modified microwave oven in the presence of particulate carbon, hydrocarbons of smaller molecular size than those present in the waste oil are generated and these have potential for use as a liquid fuel. Hence an environmentally unfriendly waste material can be transformed into a useful resource and serves as an alternative source of hydrocarbon energy.

The recovered pyrolysis oil demonstrated a calorific value comparable to transport-grade fuels, and the oil was found to contain substantial concentrations of light aliphatic and aromatic hydrocarbons that could also be used as a chemical feedstock<sup>1</sup>. The oil product showed high recovery (~90%) of the energy present in the waste oil, and is also relatively contaminant free with low sulfur, oxygen, residue, toxic PAH and metal content<sup>2</sup>. The microwave-heated pyrolysis can be performed in a continuous operation, and the apparatus described which is fitted with magnetrons capable of delivering 5 kW of microwave power is capable of treating waste oil at a feed rate of 5 kg/h with a positive energy ratio of 8 (energy content of hydrocarbon products/electrical energy supplied for microwave heating)<sup>3</sup>. Our results indicate that microwave-heated pyrolysis shows exceptional promise as a means for recycling and treating problematic waste oil.

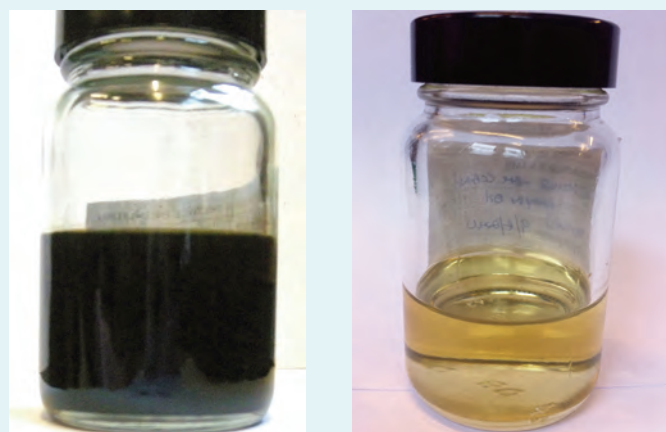


Figure 1. Used automotive engine oil (left) can be transformed into valuable fuel (right) using the microwave-heated pyrolysis method<sup>3</sup>.

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## Biophotovoltaics – Solar Energy Produced by Living Organisms

*Alistair McCormick, Alex Driver and Paolo Bombelli*  
*Electro Chemical and Micro Engineering Group*

The sun is the ultimate source of life on Earth. It supplies us with vast amounts of energy and is the source of all traditional fossil fuels used today. However, fossil fuel usage has several drawbacks: it is considered environmentally unfriendly (burning fossil fuels is the main contributor to the greenhouse effect), usage is subject to political risk and fossil fuel resources are destined to run out. Therefore there is an urgent need to develop new energy technologies that can provide a renewable, carbon neutral source of power and directly harnessing solar energy is seen as an attractive option. As such development of efficient solar cell systems to capture even a small fraction of our enormous solar reserve is currently an important scientific and engineering challenge.

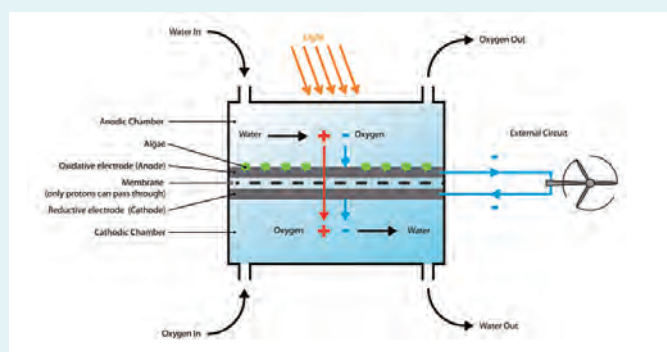


Figure 1. Biophotovoltaic cells are a new hybrid technology that uses photosynthetic organisms to produce electricity. Living algal cells can be placed inside the anodic chamber of a two electrode system separated by a membrane that allows only protons to pass through. Electrons produced during photosynthesis flow through an external circuit and then re-combine with protons and oxygen in the cathode chamber to form water. The resulting current flowing in the external circuit can be used for electrical power.

Nature has been harvesting energy from the sun for millennia through the process of photosynthesis. However, botanical species have a notorious reputation for photosynthetic inefficiency - most plants only convert about 0.25% of the sunlight that falls on them into biomass. Despite this seemingly meagre effort, it is estimated that photosynthetic organisms (including algae and plants) together harvest ten times as much energy from the sun as we utilise through fossil fuel consumption.

Several technologies have been developed to emulate the photosynthetic process. The most successful of these are synthetic solar cells based on the photovoltaic effect (e.g. silicon solar cells). Unlike photosynthetic organisms, these devices are able to convert energy with a much higher efficiency (10-15%). However, those technologies are based on the use of expensive, high purity semi-conductor materials. An ideal solar energy technology would attain the high energy conversion efficiency of synthetic systems whilst keeping the inherent merits of a low-cost biological approach. With this aim in mind, a recent collaboration between four departments in the University of Cambridge has led to the development of a new hybrid technology for harnessing solar energy, called Biophotovoltaics (BPV).

BPV devices are biological solar cells that can generate electricity. This is achieved by harvesting energy from the photosynthetic activity of living organisms, such as algae. When light falls on algae cells, a series of internal reactions take place which split water into protons, electrons and oxygen. These three products are vital ingredients for transforming carbon dioxide and other inorganic materials into food for the algae to grow. BPV exploits this process to generate electrical energy in a system very similar to a battery (Figure 1). The first BPV devices have recently been constructed and tested



Figure 2. Current BPV prototypes produced at the University of Cambridge. Algae (top left and right) and moss (bottom left) designs can presently produce enough energy to power small electronic devices.

in the laboratory. So far, they have shown great promise for powering small electronic devices (Figure 2). Although preliminary results are exciting, there is still a great deal of research required before Biophotovoltaics can be developed into a commercially viable technology. For example, currently no one fully understands the biological pathways involved in power outputs. Solar conversion efficiencies are also still much lower than those for synthetic solar cells. To tackle such problems, the BPV consortium in Cambridge uses a unique interdisciplinary approach. A wide range of techniques and skills from a variety of fields are employed including electrochemistry, micro-fabrication, chemical synthesis, molecular biology, and mathematical modelling. Their work is currently focussed on developing a better understanding of the processes occurring within these 'biological batteries'.

The long term target for BPV research is to produce an economical device with low manufacturing costs and competitive energy conversion efficiencies within the next two decades. Although BPV cells may be destined to remain less efficient than synthetic silicone cells, their biological advantages, such as renewability and ability for self-repair, may lead to BPV systems becoming a highly useful alternative energy resource. Other possible uses of BPV technology include the co-generation of chemicals (e.g. formic acid which can be used as a fuel) and the production of hydrogen.

With this in mind, scientists in the BPV consortium scientific agreed to take part in a collaborative project with designers from the University's Institute for Manufacturing to look into the future and examine some possible applications for BPV technology (Figure 3).



Figure 3. Futuristic designs for BPV technology include a floating sea water desalination generator (left). BPVs do not require land and thus could be up-scaled as off shore power stations (centre). A moss-powered table that stores solar energy is currently under construction (right).

A brainstorming session led to a range of concepts for potential products, including a BPV solar panel array, a near-shore generator that harvests desalinated water, and a garden table that generates and stores energy during the day that can be used in the evening (the latter is currently under construction). The team also considered the idea of an off-shore BPV power station consisting of several vast floating 'lily pads' coated in algae. The power output per unit area of such a BPV power station would ideally match that of an equivalently sized offshore wind farm ( $5\text{--}6 \text{ W/m}^2$ ), which will be enough to exploit this technology at a commercial level. Such a power station would even generate energy during the night as a result of the natural excess energy stored inside the alga cells during daylight hours.

Following this, the scientific team asked the designers to build a prototype for the BPV solar panel array. A 3D computer model was produced which was then used to manufacture and assemble the components in the engineering Department of Engineering workshop (Figure 4).



Figure 4. A BPV solar panel array (right) could be a useful household power supplement. Based on designs from the Cambridge Institute for Manufacturing (left), prototypes are currently being tested (see Figure 2)

The working device is shown in Figure 2, and has proved invaluable in communicating the potential of the technology to colleagues, potential investors and members of the public. An array of these devices could be placed on a rooftop to provide a portion of the building's power requirements. The advantages of this device are that it is environmentally friendly and easy to manufacture compared with conventional solar panels. Furthermore the algal bio-electrical catalysts require only water and sunlight to survive and generate energy. The oxygen produced at the anode escapes into the atmosphere whilst the water produced at the cathode



could either be harvested or left to evaporate. No harmful chemical wastes are produced during the process and once exhausted the devices are easy to recycle. Our green future has certainly never looked brighter!

The BPV consortium has also recently had two manuscripts accepted in the journal *Energy & Environmental Science*;

P. J. Bombelli, R. W. Bradley, A. M. Scott, A. J. Philips, A. J. McCormick, S. M. Cruz, A. Anderson, K. Yunus, D. S. Bendall, P. Cameron, J. Davies, A. G. Smith, C. J. Howe and A. C. Fisher. Quantitative analysis of the factors limiting solar power transduction by *Syechocystis* sp. PCC 6803 in biological photovoltaic devices. *Energy & Environmental Science*, In Press.

A. J. McCormick, P. J. Bombelli, A. M. Scott, A. J. Philips, A. G. Smith, A. C. Fisher, C. J. Howe. Photosynthetic biofilms in pure culture harness solar energy in a mediatorless bio-photovoltaic (BPV) cell system. *Energy & Environmental Science*, In Press.

#### **The BPV consortium:**

Alexander Anderson<sup>3</sup>, Derek Bendall<sup>2</sup>, Paolo Bombelli<sup>1</sup>, Robert Bradley<sup>2</sup>, Petra Cameron<sup>5</sup>, Sonia Cruz<sup>3</sup>, Julia Davies<sup>3</sup>, Alex Driver<sup>4</sup>, Adrian Fisher<sup>1</sup>, Chris Howe<sup>2</sup>, Anuphon Laohavisit<sup>3</sup>, Alistair McCormick<sup>2</sup>, James Moultrie<sup>4</sup>, Carlos Peralta<sup>4</sup>, James Phillips<sup>1</sup>, Amira Redissi<sup>1</sup>, Alison Smith<sup>3</sup>, Rebecca Thorne<sup>5</sup>.

1. Department of Chemical Engineering and Biotechnology, University of Cambridge, New Museums Site, Pembroke Street., Cambridge CB2 3RA;

2. Department of Biochemistry, University of Cambridge, Building O, Downing Site, Cambridge CB2 1QW;

3. Department of Plant Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EA;

4. Institute for Manufacturing, Department of Engineering, University of Cambridge, 17 Charles Babbage Road, Cambridge CB3 0FS;

5. Department of Chemistry, University of Bath, 1 South 1.20, Bath BA2 7AY.

#### **CEB Alumni Speaker Series**

The 2011-12 series will kick off with a talk by alumnus Dr Les Bolton, Advisor in Reaction Engineering at BP on 'The Chemical Engineering Challenges of Developing Novel Biofuels'.

When: Thursday 27<sup>th</sup> October, 4pm

Where: Lecture Theatre 1, Shell Building, New Museums Site.

These talks will take place on Thursdays at 4pm unless otherwise stated. Other talks on:

24<sup>th</sup> November 2011

26<sup>th</sup> January 2012

26<sup>th</sup> February 2012

26<sup>th</sup> April 2012

24<sup>th</sup> May 2012

Talk titles and speakers will be confirmed in future issues.

#### **'Welcome to the department' Pub Night**

A chance for all department members, new and old, to talk, drink and be merry.

Friday October 14<sup>th</sup>, 5pm at the Eagle Pub.

Department Pub Nights will then be on the second Friday of every month (venue and details to be announced).

#### **CUEN Freshers' Squash**

Cambridge University Energy Network will host a Freshers' Squash on Friday 21<sup>st</sup> October, at 6.30pm – 8.30pm in the Common Room, Graduate Union.

Contact: [wl247@cam.ac.uk](mailto:wl247@cam.ac.uk)

#### **Want to learn more about the exploitation and commercialisation of research?**

*Essential Skills for Research Entrepreneurs* is a free transferable skills training course open to PhD students and post-docs from the CEB department for the 2011-12 academic year. Contact Dr Sarah Rough ([slr1002@cam.ac.uk](mailto:slr1002@cam.ac.uk)) for details.

## Career Opportunities with Stroud

Ben Wilson

Stroud Associate



### Who we are

Stroud Consulting has been recognized as the 'Best Small Firm to Work For' in 2008 and 2010 by Consulting Magazine (runner-up in 2009). Stroud's consultants are smart, driven, energetic, motivated, and fun. We are a young company, growing to ~75 consultants in 2011, while holding fast to our dynamic culture and collegial, entrepreneurial spirit.

We are a small, rapidly growing, management and operational improvement firm. We are experts in unleashing potential from existing assets, delivering step change results and driving significant cultural change within organisations.

We achieve this by applying our highly structured, focused approach and methodology to tackle the tough technical problems that have become accepted norms and roadblocks to improved performance. We are abundance thinkers in that we believe there is opportunity to significantly improve everywhere – even for industry leaders. We do not constrain ourselves to benchmarking. This approach addresses any deeply held beliefs that have caused unrecovered opportunity to exist. In this way it is additive to, and leverages our clients own engineering technical capability.

Almost all of our growth comes via word of mouth and direct referrals from previous clients which is testament to the great results that we deliver. Where we really add value is in working alongside people to uncover opportunities that they didn't know existed and recover opportunities they previously thought impossible. This collaborative approach ensures that we deliver results at an exceptional rate whilst building capability and abundant thinking within the client organisation.

Our clients work with Stroud when they want immediate, breakthrough results. We love rolling up our sleeves and working alongside our clients to solve their toughest operational challenges. We work in many different sectors including energy, food and beverage, agribusiness, chemicals, finance and more.

### Working with Stroud

Stroud welcomes applications from undergraduates and postgraduates with the right to work in the UK and Europe.

**Training:** The Stroud development program provides unsurpassed personal growth. You will work face-to-face with senior-level clients within days of joining and dramatically grow your leadership skills through leading client teams to generate tangible, head-turning results.

Off-the-job training includes:

- 15 days of induction training in your first 100 days
- A dedicated coach to help you maximise your rate of development
- Annual Stroud International week-long conference to share best practice
- Six-monthly career-planning sessions with a Partner or Principal

Total number of vacancies this year: Eight in London, 20+ globally

Salary Range in 2011: £36,000 + £4,000 starting bonus

**Method of application:** To apply attend one of our Information Sessions at the end of which we will administer a short aptitude test. Applicants passing the test will be invited directly to interview.

### Our main information session is:

17<sup>th</sup> October, 7:00pm, Peterhouse.

After the session there will be an informal buffet where you can meet some of our consultants.

Contact (for applications): Lisa Phillips

Telephone No.: +44 (0) 8700 102 106

Email Address: eu.recruitment@stroudconsulting.com

Website: [www.stroudconsulting.com](http://www.stroudconsulting.com)



## Trials and Tribulations of Looking for a New Job

Dr Robin Chrystie (2001 – 2010)

**‘The World is your oyster – see laterally’**



The juggling act of living independently and applying for jobs in different fields required organisation and tenacity. Practice does make better, in respect of attending assessment centres - it really is advisable to be yourself, within limits – this is to ensure that you are more relaxed and that

there is a good match between you and the organisation long term.

After marathon-like patience, I finally landed a position at PricewaterhouseCoopers (PwC) as a Tax Associate. It was a steep learning curve in many respects, namely in terms of learning something of very different character, becoming accustomed to London life and becoming familiar with the commercial environment. The latter was quite a challenge in that colleagues from a variety of backgrounds can result in interesting office politics. After some time, it transpired that I was finding tax work more and more unsatisfying with little room to vent my creative streak, which proved invaluable for engineering research. The moral of the story here is to pursue a career that you excel in and enjoy! Time to migrate to greener pastures.

More lateral reflection resulted in Engineering, Management Consulting or Whitehall Civil Service as further possibilities. This was a ripe time to amalgamate my ambition to work overseas at some point along with looking for a more fulfilling career. I considered Silicon Valley, Melbourne, Washington DC and Saudi Arabia. The latter caught my eye, and since I realised that tax is not my forté, Saudi Arabia was the natural choice. Meanwhile, I am pursuing very interesting research in clean combustion as a

Postdoctoral Fellow at King Abdullah University of Science and Technology (KAUST) at Jeddah. This line of research is similar to my Doctoral studies using lasers, optics and electronics, and explosive substances. In my spare time, I look forward to making the most of the recreational opportunities available here at KAUST, such as jet skiing and deep sea diving in the Red Sea, and learning a little Arabic.

In conclusion, when directing your own journey, remain open minded and light-footed, especially at the beginning of your career. Hunting for a good position is tricky but well worth the investment – so remain tenacious, and most importantly, be true to yourself and follow your natural interests.

Adios, or in Arabic: **نالف ميريكتل قلفج**

## Reminiscing the Past

Barry Hedley ChEng Alumnus 1964-1968

Fellow, Judge Business School

Emeritus Fellow, Gonville & Caius College

Dear friends

Like the other long-graduated alumni, I very much enjoyed returning to the department recently to celebrate our ‘roughly forty year’ reunion. Following the reunion – possibly sensing I was a soft touch – Elena Gonzalez, Professor Slater’s redoubtable assistant and powerful right hand person, asked me for a few personal reminiscences of my days in the department in the late 60s, hence my letter:

My class was one of around twenty blokes, no women sadly, but small enough for everyone to know everyone else and there is no doubt we all got on very well and felt like a fortunate small brotherhood within the larger University. I was one of those who came across from the Mechanical Sciences Tripos, which meant there was some hard work to be done the first year on the Chemical Engineering Tripos learning some Chemistry. I particularly recall the physical rigours this imposed, as it seemed that almost every day there was timetabling tyranny, which would have a lecture ending in the Chem Eng Department at the same time as the next lecture was starting in the Chemistry Labs. This meant a lot of furious pedaling to cycle the length of Tennis

Court Road both rapidly and perilously only in order – invariably – to arrive late and panting under the disapproving gaze of whoever was delivering the Chemistry lecture that day. But there were compensations. The Chemistry lectures – especially, as I recall, those on reaction mechanics delivered by Prof Denbigh – enjoyed the benefits of one of those exotic miracles of modern technology, an overhead projector. We did not have these in the Engineering labs; nor did we, as I recall, in the Chem Eng Dept., both relying on good old fashioned blackboards and chalk. But though impressive, the projectors held drawbacks for the lecturer. Usually someone would have sneaked into the lecture theatre in advance of the lecture, wound the transparent film forward on the projector, and inscribed on it suitably witty cartoons or comments on the lecture (or lecturer) and usually the odd licentious limerick as well. And then, of course, scrolled the film back so that the insertions would be encountered at random moments during the lecture. Try as he might, when he encountered these insertions, poor Prof Denbigh was not able to roll past them fast enough to prevent his audience deriving full enjoyment from their scurrility. Somehow, despite these distractions, we learnt enough chemistry to stay on the Chem Eng straight and narrow...

My strongest recollections are of the research project my partner Peter Whalley (now sadly deceased) and I carried out under the supervision of Professor John Davidson. Ever since, when hearing the theme song of West Ham United – ‘I’m forever blowing bubbles’ – I remember that work. On our recent reunion, visiting the Chem Eng workshops, I was acutely reminded of the practical wisdom and advice that department was able to dispense regarding the design of equipment and conduct of the experiments. Our project involved taking a mass of pressure readings along a vertical bubble column, under many varying conditions of gas and liquid flow, in order to see which theoretical equations best described the voidage that resulted in the gas/liquid mixture. Processing these data was really only practicable using the department’s already venerable IBM computer. Peter and I typed out massively lengthy punched tapes, one containing our analysis program, the others the actual data. We nervously inserted these into the computer’s optical reader. (Seemingly

impossibly esoteric technology to us at the time, I’m sure it would accord equal amazement today to a generation more used to iPhones, iPads and laptop PCs!) Actually getting the computer to do anything seemed to require the manual entry of incredibly long strings of machine code – all binary, shapeless sequences of 0s and 1s – and any clumsiness on entry produced error messages that were even less comprehensible than our original data, and not infrequently, high pitched whizzings and whirrings from the infeasibly large hard disk stacks that dominated the end of the computer room like giant juke boxes. Again, miraculously and despite all these cruel and unnatural punishments, we somehow managed to complete our project and get our theses accepted by Prof JFD...

Over the years, I’ve thought about these happy days and the wonderful teaching we received, more often than the faculty in the department would imagine. My classmates and I owe them all a great debt, and the recent reunion was a delightful opportunity to come back and relive those early and formative experiences as well as to learn more about the department’s new directions and continued success and global recognition. Many thanks to Professor Slater and all involved in organizing it!

Yours,  
**Barry**



*Professor Slater with at Reunion Lunch with 1962-72 Alumni at Sidney Sussex College, 8 July*

## Touch World Cup

Dr Daniel Holland



Dan in action against Japan

emphasises speed and ball handling skills over strength or power.

I have been playing for the England Men's Open side since 2009, but the World Cup was by far the most exhilarating tournament I have been involved in. We were a new side with a mix of young players to bring exuberance and a few older heads to keep them in check. Our tournament began well with wins over Ireland and Germany, but we lost to a strong Japanese side. These results put us through to a round robin competition with the top eight sides in the world. We beat France but then narrowly lost our games against Japan (again), the Cook Islands, Australia, and New Zealand. Our best performance was against South Africa, ranked 3<sup>rd</sup> for the tournament. We managed to get ahead of them early on and held our lead until with about 60 seconds left they managed to sneak a touchdown to tie the game. A final frustrating loss to Scotland left us 7<sup>th</sup>. Overall the tournament was a huge success. Australia and New Zealand dominated the finals, with Australia winning five of the seven divisions. England's best result was in the Men's over 30s division who finished 2<sup>nd</sup>.

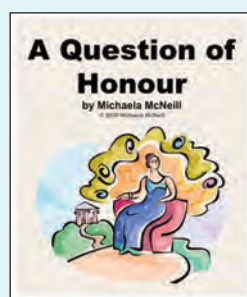
The sport is rapidly growing in the UK, with over 12000 people playing in leagues across the country. One of the reasons for this popularity is that it is one of the few sports where men and women compete together. Cambridge is blessed with a particularly strong league and players of any ability or experience are welcome – so let me know if you are interested!

In June 2011 I was part of the England Men's Open side competing at the Touch World Cup in Edinburgh, Scotland. Touch started in Australia in the early 1960s and is derived from rugby league. It is a fast paced game where the goal is to score touch downs as in rugby. It

## Receptionist Michaela McNeill's Hidden Talent

Who would have known long-serving member of staff, Michaela, receptionist at the Chemical Engineering site, has just got her first book published on Kindle through Amazon. Keen reader and history lover Michaela has just revealed that her book *A Question of Honour* is available for purchase on the Amazon website. On being asked how this book came about she replied:

"The idea for *A Question of Honour* came from watching sword and sandal epics and thinking I could write something in a similar vein. The story first started way back in my early teens after watching classic tv serials like *Robin of Sherwood* and *The Moon Stallion* and I have always loved watching films like *Quo Vadis*, *The Rise and Fall of the Roman Empire* and more recently *Gladiator*. Four years ago I was recovering from a major operation and rather than succumb to daytime tv, I decided to put pen to paper and *A Question of Honour* was born.



It is an historical novel set at the time of the Roman occupation of Britain. It tells the story of Amena, a young British girl who is training to be a priestess when the Romans arrive and destroy her home. She finds herself sold into slavery and joins a Roman family in Sicily. She then falls in

love with Marius, a member of the family but the situation is complicated when she meets his brother Marcus who also declares his love for her. This is a coming of age story telling us about the feelings of a young woman growing up in a strange situation and how she adapts."

You can read a Kindle book by having a Kindle reader or reading from a PC, iPad, iPhone, Touch or Android. Show Michaela your support by buying her book on [www.amazon.co.uk](http://www.amazon.co.uk).



### Local Music, Global Impact

*Elena Gonzalez and Oxjam Cambridge music fest take over the City*

The Takeover is part of a charity national music festival in aid of Oxfam coming to Cambridge for the first time on Saturday 22<sup>nd</sup> October. Oxjam Cambridge launched with a beach party on Sunday 7<sup>th</sup> August at 'Cambridge Beach' @ The Emperor to kick-start its fundraising campaign. The charity gig with talented jazz singer Joanna Eden aboard the Riverside Georgina boat on 24<sup>th</sup> September sold out within days. The festival will culminate with the Takeover music festival in October.



*Elena (right) with the Oxjam Takeover Team*

A keen and enthusiastic team of volunteer organisers led by Mike Wilson (Strawberry Fair Vice-Chair) are working together with other volunteers, established local artists and venues across the city to bring the best of local music talent to your doorstep. One of these key organisers is our very own Elena Gonzalez, Professor Slater's PA, who has spent her spare time since May acting as Marketing Co-ordinator for Oxjam Cambridge. She commented "The experience has been brilliant so far; very excited to be promoting music, which I love, as well as local artists and participating venues, all for a great cause. I am currently involved in publicity and event organising at CEB but the thought of dealing with local media was daunting at the beginning. However, it has been a very useful and rewarding experience so far. I have learnt a lot from it and made great contacts. This has also given me additional skills that I can now put to practice in my day-to-day job."

The team is taking one step at a time and is currently busy finalising details of the upcoming Takeover a

multi-venue charity music festival, an all-dayer in aid of Oxfam aimed at the local community including students and regular gig-goers.

Help from local talented artists, ethical and green venues and businesses have been key in making this event happen. Takeover Manager Mike Wilson commented "Oxjam Cambridge Takeover could not taken place without the help of our main sponsors. We would like to thank Cambridge Building Society and Local Secrets for their generous donations as well as our main media partners Envision TV and Affinity Radio, who have been following our every move over the summer helping us spread the message of our charitable work and helping us promote Oxjam Cambridge events. We are hoping to raise £3000 with the Takeover music festival, with all the proceeds going to Oxfam helping save millions of lives across the world."

This is certainly the sound of something big happening not to be missed with lots of surprises in store including burlesque/cabaret acts on stage, short films and two late-night venues to spice up things even more! All six confirmed venues are located on Hills Rd/Regent St: The Emperor, The Alma, Great Northern, The Q Club, De Luca Cucina and the Fountain will all be hosting great acts on the day. All in all, over 140 artists performing 40 hours of entertainment packed in a one-dayer with an amazing line-up so far including the great Biojumino, Keltrix, Sunday Driver and the Best of Ezio's Songsmith Sessions.

Advance tickets are available for just £8 online from [www.wegottickets.com/f/2881](http://www.wegottickets.com/f/2881) as well as from participating venues for £10 on the day. For more information you can find Oxjam Cambridge on [www.oxjamcambridge.org.uk](http://www.oxjamcambridge.org.uk) and [www.oxfam.org.uk/Oxjam/whatis/oxjam](http://www.oxfam.org.uk/Oxjam/whatis/oxjam) as well as Facebook, Twitter and Myspace. To donate and help us reach our fundraising goal, please visit [www.justgiving.com/oxjamcambridge2011](http://www.justgiving.com/oxjamcambridge2011)

'Oxfam GB is a registered charity (England and Wales No202918, Scotland SCO039042) & a member of Oxfam International. Oxfam works with others to find lasting solutions to poverty and suffering.'

## A warm welcome to...

Dr Santanu Basu  
Simon Jobst  
Nora Backer

## Goodbye to...

Dr Damien Vadillo  
Faysal Al-Khuleafi

## Long-service Leavers

*CEB Focus* sends a warm goodbye to some key members of staff, who are retiring after many years of service to the department. We wish Linda Craft, Barrie Goddard, Surinder Sall, Sabine Deering, Professor Malcolm Mackley and Phil Salway, a happy retirement and the best of luck in their future endeavours.

**Baptiste Salley**  
*MPhil ACE Student*



I came to Cambridge in October 2010 to start an MPhil degree in Advanced Chemical Engineering, as part of my final year with the Ecole Polytechnique (France). With a large international battalion of MPhil students ('the best so far', Dr S. R\*\*\*\*, 2011, personal communication), I attended various courses in ChemEng, engineering and business. In mid-March, I started a five-month research project supervised by Dr Ian Wilson on fluid dynamic gauging of biofilms, working with Patrick Gordon and Dr A. McCormick. I developed a new technique to measure the thickness and strength of biofilms which can be used to monitor the growth of cyanobacteria on different substrates.

The time I spent here has been both intellectually and socially rewarding. This year was the final chapter in my life as a student and it was quite a nice way to end my studies! I am entering the working world in September when I'll be a reservoir engineer for Total in Paris La Défense.

**Mark Deimund**  
*MPhil ACE Student*



I first arrived in Cambridge as an MPhil student during September 2010, after completing a research internship with ExxonMobil in New Jersey, USA.

As part of the MPhil programme, I completed two terms of courses in a variety of subjects, ranging from Macroeconomics to Modern Metrology. During the research portion of the programme, I worked with Professor Clemens Kaminski to further develop a new type of optical fluorescence microscopy, localisation microscopy, which can provide lateral image resolution on the order of tens of nanometres. While the MPhil programme taught me quite a lot about engineering and business, my time at Cambridge taught me a lot about myself as well. I enjoyed meeting students from all over the world, as well as travelling to new places when possible. I also joined the Churchill College Boat Club, rowing for my college in both the Lent and May Bumps races.

I will soon begin my doctoral studies at the California Institute of Technology in Pasadena, California.

## Dear Dr Sarah,

You have supervised various courses and research projects in this department. Now that the new academic year is here, what tips do you have for both graduate and undergraduate students for managing our own projects? What do you think is the secret to being ‘successful’?

Thanks,

*Pablo Arias, PhD Student*

## Dr Sarah says...

Ah, success. Can you smell that sweet aroma? Could be an ethyl ethanoate leak somewhere?

So, you want to know the secret? Well, here it is: it’s not about being clever, although it does help and can save time, but it’s not essential; it is about being efficient and knowing how the system works. Here are some pointers that helped me find my feet when I was a PhD student (in the days of floppy disks). I hope you can attain resonance with some of them.

### Know how to get the best out of your supervisors:

They are your ‘guides’ in the academic underworld; but remember, they too were once human. They will have good and bad days, just like everyone else – but don’t take it personally. I find that a meeting with a student will tend to be particularly fruitful if I have something to look forward to, like a slice of organic carrot cake, say, or perhaps one of those hairy coconut puff pastries (you don’t see them much nowadays, do you? I couldn’t even find one on Google images). But that’s just me. I don’t want to be prescriptive.

**Be methodical but flexible:** Better to be the reed than the oak tree.

**Divide and conquer:** Split up seemingly endless, mind-numbingly boring tasks into manageable bite-sized chunks; then at least you can have some sense of achievement after completing each chunk.

**Learn to ‘get in the zone’:** How can you tell if you are there? Well, it’s a bit like The Matrix – no one can tell you what it is, you have to experience it to know it.

Some say it’s a dangerous way to undertake academic research – pah! I say – they are just scaremongers. I go there now and again to check out the landscape, but I still manage to extract myself in time to perform mundane but necessary bodily functions.



*Dr Sarah getting in the zone with her new hairstyle.*

### If something can go wrong, it probably will:

That’s known as Sod’s Law (or Murphy’s Law, if you’re a Puritan); so always have a Plan B.

**Bad results are still results:** I’m sure even Einstein had a look back at his notes to check which equations didn’t work out too well – ‘Und zhis is when I had E being proportional to  $m^2$ . Ho ho, I von’t be doing zhat again!’

**Bear in mind Occam’s Razor:** *‘pluralitas non est ponenda sine necessitate’*. Rough translation: *‘Don’t fuff about’*.

### Step back now and again to look at the whole picture:

You don’t go travelling aimlessly for four hours and then decide to look at the map to see if you’ve reached your destination – well, women don’t anyway.

**Learn to delegate:** Now, some people think that delegation involves off-loading responsibilities onto others so that they get the blame when it all goes wrong. But I disagree with this pessimistic attitude. One should view it as you getting all the praise for effective out-sourcing when it all goes right. But here’s the rub...

### ...If you want something done, do it yourself:

Unfortunately this maxim can only really be appreciated in hindsight.

And finally, but most importantly ...

**“...Have a positive attitude:** Be the guy who gets things done – don’t be the other guy.”



## Theorising over Spilt Milk

Alastair Clarke

PhD Student, Fluids and Environment Group

To make a lot of money quickly, chemical engineers want to transfer materials with maximal speed and minimal loss. Fortunately, the daily routine of carrying a cup of tea around has given us an intuition for the physics of sloshing i.e. the motion of the tea's free surface when the cup is perturbed. We know that a large jolt to the cup will cause spillage but what happens if the tea is forced to oscillate very quickly with a small displacement? Will it spill? R. A. Ibrahim's book<sup>1</sup> describes some models which can help to answer these questions.

Consider a cup of height  $H$  and radius  $R$  which is  $h/H$  full of tea, as sketched in Figure 1. We assume the fluid is inviscid, incompressible and irrotational and our model will account for gravity effects but ignore surface tension. The behaviour is governed by Laplace's equation,  $\Delta\phi = 0$ , where  $\phi$  is the velocity potential and  $\Delta$ , the Laplacian operator. To describe the fact that tea cannot flow through walls or out the base of the cup, we say  $\partial\phi/\partial r = 0$  at the cup walls and  $\partial\phi/\partial z = 0$  at the base of the cup. There are two boundary conditions at the free surface. The transfer between kinetic energy and potential energy as the surface swings to and fro is described by  $g\eta - \partial\phi/\partial t = 0$ , where  $g$  is acceleration due to gravity,  $\eta$  is the height of the free-surface from the origin and  $t$  represents time. Secondly, the surface velocity is given by  $\partial\phi/\partial z = -\partial\eta/\partial t$ .

If you oscillate your cup of tea horizontally at a frequency,  $f$ , and amplitude,  $a$ , waves form on the surface. According to our linear model the free surface will resonate at a critical frequency of:

$$f_r^2 = [g e / R] \tanh (h e / R) \quad (1)$$

where  $e$  is a root of Bessel functions of the first kind taken here as 3.832 to find the lowest resonant frequency<sup>2</sup>.

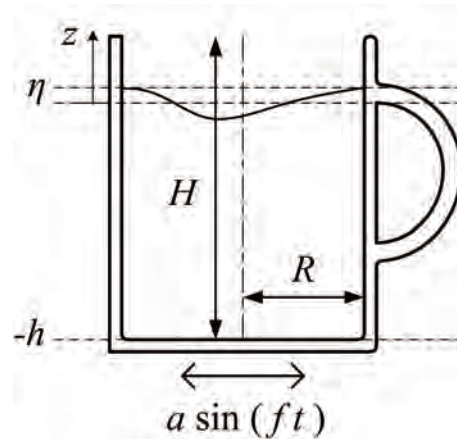


Figure 1. Sketch of the cup. The  $z$ -coordinate originates at the initial free surface position and the  $r$ -coordinate radiates from the centre of the cup.

The model also predicts the maximum surface height ( $\eta^*$ ) at the wall for a given amplitude:

$$\eta^* = k a \quad (2)$$

where  $k$  is a coefficient:

$$k = \text{Fr} [ 1 + 2 \text{Fr} / (e^2 - 1)(\text{Fr}_r - \text{Fr}) ]$$

$\text{Fr}$  is the Froude number ( $= f^2 R / g$ ) and  $\text{Fr}_r$  is the Froude number at the resonant frequency.

Let's say that  $R = 4$  cm,  $H = 10$  cm and our cup is nine-tenths full ( $h/H = 0.9$ ), then eq. (1) gives us  $f_r = 31$  Hz (31 cycles per second!). At what frequency will our tea spill if  $a = 0.2$  cm? Eq. (2) predicts 28 Hz. This is quite close to the resonant frequency so perhaps a linear model is not appropriate to predict the exact surface height for this scenario.

*Finally a tea-time teaser for you ... why is it particularly bad for clumsy people to have dirt on the surface of their tea?*

### References

1. Ibrahim, R. A., 2005. Liquid Sloshing Dynamics: Theory and Applications. Cambridge University Press. pp. 5-15, 90-92.
2. DMS and HCSS, 2008. Data Book, Dept. of Chemical Engineering and Biotechnology, University of Cambridge. pp. 17.

## 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](mailto:ceb-focus@ceb.cam.ac.uk)

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