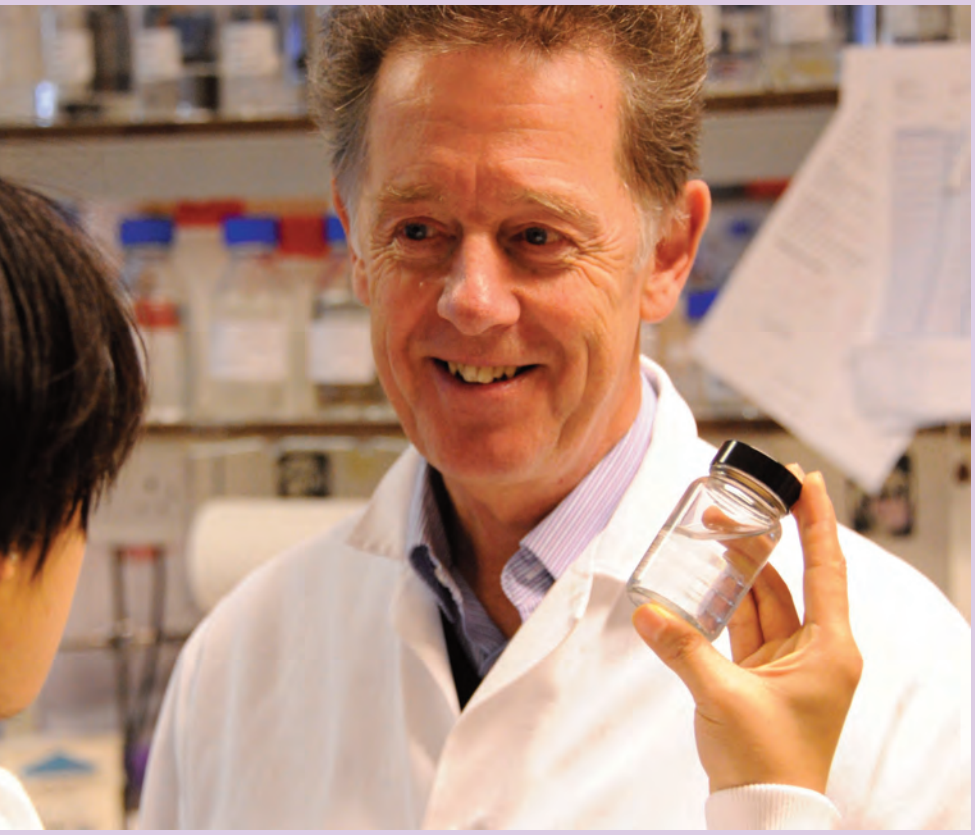
UNIVERSITY OF CAMBRIDGE

Lent 2014
Issue 11
www.ceb.cam.ac.uk

CEB *Focus*

Department of Chemical Engineering and Biotechnology



Research better done in Academia or Industry? p.3

In this issue

Message from HoD	2
Editorial	2
Front Cover Article	3
Undergraduate Focus	5
Graduate Hub	7
Teaching Matters	9
Research Highlights	10
Research Feature	12
CEB Innovation	14
Industry Business	18
Achievements	20
Alumni Corner	21
Department Events	22
People Focus	23
Staff Room	24
Dear Dr Sarah	25
Tea-Time Teaser	27

Learning and Teaching Review Results p.9

Camel Milk Cosmetic Venture p.14

Alumnus Gift: MBE Bursaries p.21

Message from HoD Professor Nigel Slater

The first edition of *CEB Focus* in 2014 finds the department eagerly anticipating the New Year. During the Michaelmas Term Professor Lisa Hall led the department's submission to the Research Excellence Framework, the new system for assessing the quality of research in UK higher education institutions, and Dr Patrick Barrie led us through our General Board Learning and Teaching Review. We must now await the final outcome of both exercises. Professor Kraft moved to Singapore to lead our new venture; the Centre for Carbon Reduction in Chemical Technology. Work on the new laboratory at West Cambridge moved up a gear and we are now starting to plan the move for mid-2015. In anticipation, we have developed a new web site that better captures our excitement and aspirations in teaching and research, which is well worth a visit on www.ceb.cam.ac.uk We wish you all a very successful New Year!

Editorial Note

CEB Editorial Team from left to right: Ning Xiao, Fanny Yuen, Elena Gonzalez, Jantine Broek and Kripa Balachandran

The *CEB Focus* Editorial Team wishes you a wonderful a start to the new academic year! Editorial Team is led by Elena Gonzalez, PA to HoD Professor Nigel Slater, assisted by fellow editors PhD students Jantine Broek and Ning Xiao with Undergraduate representative from CUCES Committee Kripa Balachandran. We would also like to give a warm welcome to PhD student Fanny Yuen, the new addition to the Editorial Team. The Editorial Team's commitment to the newsletter project and their personal contribution along with their enthusiastic ideas help further develop the publication look and editorial content. We are always keen to see new faces so please email us on ceb-focus@ceb.cam.ac.uk if you are interested in joining us.

The Cover Article focuses on the eternal debate of whether research is better done in industry or academia. Evaluate the pros and cons yourself after reading the arguments given by our very own Professor Chris Lowe and Medimmune CEO Paul Varley, who went head to head at a recent debate run by Oxbridge Round Table (OBR) at the Cambridge University Union. The Industry Section celebrates membership renewal of all our Teaching Consortium of companies (TC) supporting our courses and also welcomes former corporate member Arthur D Little, which has now rejoined TC.

Research Highlights tells about projects with huge impact CEB young researchers are currently working on such as a New Perspective of Coke (James Ericson), a Techno-economic Analysis of the Performance of Antifouling Coatings (Leonardo Gomes da Cruz), Bio-polymer based Delivery System for Mammalian cell (Jessica Ocampos) and Carbon Nano-tube Supercapacitor (Hongkai Ma). The Research Feature presents a very interesting piece of research from a recently published paper by Dr Dr Vassilios Vassiliadis on *Computer Algebra Systems Coming of Age: Dynamic Simulation and Optimisation of DAE systems in Mathematica (TM) Computers & Chemical Engineering'.* Also worth noting is the interview with alumna Dr Pen Shihab featured in CEB innovation, which highlights her huge entrepreneurial achievement in Jordan and her camel milk cosmetic venture, Skinue, now taking the US by storm.

Among some of CEB's most committed alumni deserving a mention for their contribution to the education of the future is Biotechnology graduate Dr Darrin Disley who very recently provided generous funding for former MBE students' Desktop Genetics Ltd and has also set up annual Carpe Diem bursaries for MBE students. They tell us about the impact of Darrin's gift has had on their studies and lives.

CEB Focus would like to thank webmaster Vanessa Blake for regularly providing photos and department members, alumni and corporate partners for article contributions. Please keep sending them to ceb-focus@ceb.cam.ac.uk. To receive a regular e-copy of CEB Focus **subscribe** by sending a message to ceb-news-request@lists.cam.ac.uk with 'Subscribe' as the subject of the message.

Is Research better done in Academia or Industry?

Elena Gonzalez

Speakers in action at the OBR Cambridge Union debate

On 28 October 2013 Oxbridge Biotech Roundtable OBR (www.oxbridgebiotech.com) hosted a debate led by OBR Cambridge Chapter President Karolina Zapadka at the Cambridge Union Society on the topic *"This House believes research is better done in industry"*. OBR mission is to 'move ideas forward, aiming to help young, business-minded entrepreneurs and those interested in the field of biotechnology push their careers forward.' Throughout the debate the speakers grappled with a number of tricky questions such as: Is academic research an efficient use of resources? Doesn't industry have much better incentives to make biomedical discoveries relevant to the health and well being of patients? Are many years in graduate school worth it just to produce scientific papers in the 'publish or perish' cycle of funding? Maybe doing a BSc and then going to industry is a better option?

After finishing a PhD many researchers will have spent about 10 years training at university but what is this training for? The number of doctorates given out by universities has increased dramatically over the last 40 years but the number of academic positions has not kept up. Then again, if the PhD leads to a career in industry, do skills acquired in academia match what industry labs are looking for?

Doctoral work in the sciences is supposed to teach students how to 'think' and 'problem solve' but isn't it really just a lesson in navigating inter-lab politics, learning niche laboratory skills, and learning how to work and thrive in an isolating environment? Certainly scientists finishing a doctoral dissertation show they can get things done and also show the ability to solve complex problems. However, could these skills not be learned on the job whilst earning money at the same time?

On the grander scale, does public investment in academic biomedical research really improve public health? Would industry not be more efficient at making the best innovations for the patient? Then again, there is a tendency in academia to knock industry-sponsored or -executed biomedical research as tainted. Corporations often have the staff and the resources to do excellent studies, however, they also have a strong financial motivation to see a successful outcome. Dr Paul Varley, Vice President of Medimmune, brought up this point during the second round of the debate.

Speaking for the proposition, Mr Thomas Saylor from Arecor Ltd. began the debate by explaining how industrial research is more economic, reproducible, and real-world applicable than academic research. However, our very own Professor Chris Lowe, who also took part in the debate, argued in favour of research in academia and he responded to Dr Varley that research does not necessarily need to be like shooting an arrow at a target, "sometimes research is like shooting an arrow at random and having the target be wherever it lands". The opposition did not fail to mention that some of the greatest scientific discoveries came about by complete accident or from blue skies research. See below a summary of Professor Lowe's insights on the subject and main points he argued:

"I started the opposition to the motion by posing several key questions relating to the wording of the proposition. A key issue was the definition of the term research, which in the broadest sense includes any gathering of data, information and facts for the advancement of knowledge, and could in principle include reading a book, surfing the net or watching TV.

However, in Higher Education, research is normally defined according to an internationally recognised publication from the OECD, the Frascati Manual, which distinguishes basic or fundamental research from applied research and development. In simple language, basic research is inquiry aimed at increasing knowledge, whilst applied research is effort aimed at using basic research for solving problems or developing new processes, products or services. According to the conventional view, academia conducts basic research i.e. research resulting in the creation of new knowledge and fundamental insight generally for the public good and usually with little commercial value, whilst on the other hand, industrial research focuses on generating knowledge with direct commercial potential.

Prof Lowe (far left) with OBR Cambridge President Karolina Zapadka (second right)

A more nuanced view suggests that these stereotypes of academic and industrial research are converging and that there are now significant overlaps between the two systems. Interestingly, both parties were in agreement on this point, which left the debate to ponder whether basic research is better done in industry. I responded very robustly with a resounding no to this point on the basis of several arguments. First, there is much more competition in the world and by 2050 Asia will be home to 50% of the world's population. University research is an essential ingredient of the "knowledge economy" of the future, i.e. an economy based on human capital rather than physical assets. Secondly, universities will contribute to the new business paradigm of open innovation. The value chain can now reside outside the company's curtilage and ideas, people and products flow seamlessly across the company's boundaries, to and from, other companies, universities and countries. Innovation is now a global game. In order to reinforce this point I noted in Merck's Annual Report (2000): "Merck accounts for ~1% of the biomedical research in the world. To tap into the remaining 99%, we much actively reach out to universities, research institutions and companies worldwide to bring the best of technology and products to Merck". I pointed out that most companies are pulling back from basic research and leaving it to the universities. Thirdly, I noted that the leading research-intensive universities are the engine room of long-term, sustainable growth and prosperity. For example, in this country, Russell Group universities (the top 24 UK universities) are major contributors to the UK economy in their own right, supporting more than 270,000 jobs and generating an economic output in excess of £30B a year (2012), up from £28B the year before, a 7% growth rate when the overall economy was flat[1]. I also noted that a study of 125 case studies across the Russell Group showed the timescale from research to first realising a commercial return averages more than 17 years, well beyond the typical investment cycle of most companies. Fourthly, there are many examples of fundamental research in universities leading to significant societal impact, even though at the time none was envisaged. I quoted examples of transistors, radio and television, DNA structure, lasers and one close to my own heart, holography. The underlying theory for holography was developed by Hungarian-born British physicist Dennis Gabor in 1947, for which he won the 1971 Nobel Prize for Physics. Gabor's discovery was serendipitous, made while trying to improve the resolution of electron microscopes, and did not have any other known applications at the time. Indeed, in September 1948 the New York Times described the hologram as "a futuristic tapestry that mysteriously recreated images out of thin air", and until the late 1950s the technique was deemed "unintuitive and baffling", of "dubious practicality" and even pronounced a "white elephant". The hologram market is now worth $14.5B a year! Finally, I pointed out that academic research is like firing an arrow into the air and painting a target where it lands, whilst industrial research paints the target first and then tries to hit it. The trouble is – you never know what is likely to be important in the future. As Albert Einstein said "If we knew what it was we were doing, it would not be called research, would it? Imagine telling your research director in industry that; I suspect he or she would promptly hand you a P45!"

[1] *www.russellgroup.ac.uk/*

A full CUCES Committee

Kripa Balachandran, CUCES IT and Publicity Officer 2013-2014

The entire CUCES Committee 2013/2014 (from left to right) Camille De Villiers, Kripa Balachandran, Jenny Overton, Supriya Gopinath, Phanos Anastasiou, Miguel Santos-Silva and George Qiao

Last term saw two welcome additions to the CUCES committee family: a Part I rep – Miguel Santos Silva and a new Postgrad rep – Camille De Villiers (MPhil). Thank you to all the other candidates who applied for these positions and showing your keenness to get involved! The Post-Grad rep is a new position to the CUCES committee – in previous years, CUCES has appeared to be a solely undergraduate-based organisation and this year, we look forward to broadening our focus to include the post-graduate community in the department!

First Impressions of CEB

Miguel Santos-Silva, CUCES Part I Rep 2013-2014

Coming from the Natural Sciences Tripos and its collection of independent departments, I was sure that ChemEng would be different; I just didn't know how. A mere two months into the academic year I have come to realise just how different the Department is.

From the very beginning it was great to feel that throughout the Department there was a sense of unity. Geographically, the fact that I now had all my lectures, supervisions, labs and academic dependencies within one department as opposed to spread out across Cambridge was great (and convenient). But location was not the only factor; it's become clear than much more than in my previous departments, ChemEng feels more like a family than an academic circle. Older students eager to calm your panic attacks, lecturers that not only welcome, but encourage us to seek out their help, and a Chemical Engineering Society (CUCES) that can advise you on just about any obstacle you encounter. I genuinely feel that from the academics to my peers, I have a support network I can count on.

Speaking of CUCES: it's great! I must admit to bias as I am part of CUCES, but when it comes to bridging communication between the different entities in the Department, and offering the critical services we as students need, it does a fantastic job. Be it a social at a pub, a year group formal, or critical careers advice and presentations by leading engineering firms, CUCES brings it all together.

Has it been a lot of work? Yes. As a Part I it sometimes feels like you're swamped amidst having to readapt to a new department while keeping up the workflow. But one thing is for sure: it's rewarding, fulfilling, and the tight knit community thanks to a small year group has no small part in that. The workload is intense and prioritising skills are often the most important aspect of academic life when you are trying to balance multiple supervisions with your lab report and exercise. But when the work is done, there is still time for formals, nights out, relaxing and having fun. So while at times we despair, these first two terms have lived up to the Cambridge cliché: Work Hard, Play Hard.

CUCES Christmas Dinner, sponsored by BP

Kripa Balachandran, CUCES IT & Publicity Officer 2013-14

Last Christmas, CUCES held its annual Christmas Dinner kindly sponsored by BP and Ernst and Young. The event took place at the now-traditional venue of Browns restaurant off Trumpington Street on Thursday 21 November – the week before Bridgemas. Despite the early date of the event, the event was a huge hit, with all the guests being well and truly engrossed in the Christmas Spirit.

This year, the dinner was kindly sponsored by both BP and Ernst and Young, the latter of which even invited one of their representatives, an ex CUCES President, Constantinos Pittas to the event. The event brought together an entire spectrum of guests from the department including PhD students, MPhils, and undergraduates.

The evening began with a lavish drinks reception by Browns' bar, later going on to an elaborate three course meal, which even included an extra of Christmas crackers!

Some of the guests at the CUCES Christmas Dinner, sponsored by BP and Ernst & Young

After the dinner, most of the attendees went over to La Raza to end the evening on a high high with live music and happy hour! The CUCES committee would like to thank all those who attended for making it a truly special evening.

Careers Events in Michaelmas

Last term, we had the pleasure of hosting several companies at the department for careers events. Michaelmas is always the most hectic term for CUCES, with about 15 careers related events through the term. All the events had excellent turn out, no doubt in part due to the excellent quantities of Pizza, juice and soft drink provided.

Each event allowed some excellent engineering companies to allow students to explore the range of options they have in the chemical engineering industry and subsequently network with their representatives – one of the presentations included an alternative careers presentation held by the IChemE!

For more information regarding upcoming careers events this Lent, please visit the CUCES calendar: www.cuces.soc.srcf.net/wordpress/current-students/events-calendar

Term Card for Lent 2014

Where Michaelmas had a number of career-heavy events, this term, CUCES have organized several social events over the next few months. Here is a brief taster of what is to come: A ChemEng Formal at Robinson College, A Brewery Tour and Trip, and last but not least, the most important event of all: The Annual Dinner!

Keep your eyes peeled for emails about this events and hope you all have a great term.

OBR Writing Competition

Are you passionate about science? Have you seen something recently that inspired you? Got a knack for writing? From 27 January – 28 February, the Oxbridge Biotech Roundtable will be holding the annual science writing competition!

All are welcome to contribute, whether you're a high school student, an undergraduate, a graduate student, or a working professional, we want to hear from you! It's simple, pick a theme, write an essay no longer than 1200 words, and send it to review@oxbridgebiotech.com with the subject heading "WRITING COMPETITION". Please, don't include figures or images! The winner, to be determined by Lisa Melton, Senior News Editor for Nature Biotechnology, will have his/her submission published on our Roundtable Review and receive £500 prize money.

The technical details and jargon used in biotechnology can often make exciting stories inaccessible to the general public. We're looking for the clever writers who can break things down, show what's really going on, and explain it in a way that's easy to understand. All we ask is that you write clearly and succinctly!

This year's topics are:

1) An example of entrepreneurship in the biotechnology industry

2) An exciting discovery in biology (recent or past)

3) An interesting development in the field of biotechnology, e.g. pharmaceutical, ecology, biomaterials, healthcare, etc.

So grab a pen and pad, crack open your laptop, and get writing! We look forward to hearing from you! For further information on the Oxbridge Biotech Roundtable and our Review, visit our website at www.oxbridgebiotech.com

Accelerate your Project through ETECH

An introduction to ETECH Projects

ETECH Projects accelerates entrepreneurship and diffusion of innovations based on early stage and potentially disruptive technologies from the University of Cambridge. The projects are run within credit bearing courses offered at a number of University departments, including the Department of Physics, the Department of Materials Science, and the Department of Chemical Engineering and Biotechnology etc.

In the last six years, ETECH Projects has been delivered across Natural Sciences, Technology and Biological Sciences University departments to approximately 500 undergraduate and postgraduate students, working with 30+ inventors, and resulted in the evaluation of over 50 novel technologies through almost 100 projects. Building on this solid foundation, ETECH Projects aims to reach out to more departments within the University of Cambridge, helping to accelerate entrepreneurship and innovation based on novel and potentially disruptive technologies.

Dr Shima Baraket, Course Director of ETECH Project Learning

Dr Shima Barakat talks about the structure and benefits of the course for students and inventors on www.cfel.jbs.cam.ac.uk/programmes/etech/videos.html

Programme Overview

Students work in teams to prepare a commercial feasibility report and present the findings to the inventors. Supervision and support is provided which covers topics such as opportunity evaluation, developing business concepts and making presentations.

The projects are underpinned by a series of faculty and practitioner-led lectures on specific themes e.g. conducting due diligence, market and industry assessment. Please note that ETECH Projects, including all students' work, are subject to strict confidentiality procedures as stipulated by the University of Cambridge.

Benefits for ETECH Project Inventors
All the inventors from Cambridge University, including all the academic postgraduate students and staff, will be completely free to join ETECH Projects.

It is a good opportunity for research staff to promote their research to potential PhD candidates.

All the involved inventors will receive a full commercial feasibility report and presentation of their novel technologies by the end of March, by a group of undergraduate students with science and engineering background, covering the following elements

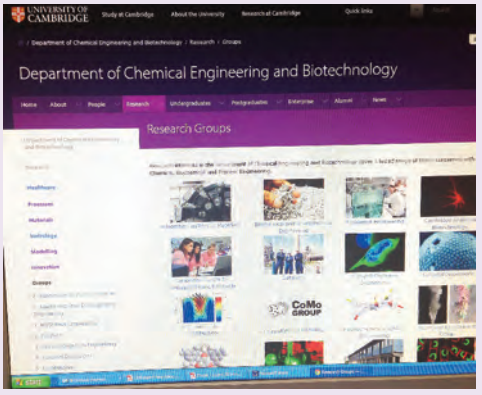
- Conducting due diligence on science and technology
- Applying creativity in commercialising novel technologies
- Stepping stone on commercialisation
- Market and industry assessment
- Identifying routes to market
- Leadership and management of emerging technologies

Apply for ETECH Projects (Inventors)
Inventors from Cambridge University or a company within the greater Cambridge area can submit a project for evaluation through ETECH projects. Projects must be for a market feasibility study of a novel technology. Proposals are submitted annually before 20 December for consideration in ETECH projects run in the New Year. Accepted project proposals will be put forward to students in the Lent term. Students will then choose which projects to work on between the end of January and the middle of March.

If you have any questions about joining ETECH Projects as inventors, please contact ETECH TA Ning Xiao through nx201@cam.ac.uk

CEB New Website Launch

Elena Gonzalez



We are very excited to have finally launched our new website design after almost a year of discussions and hard work on web development!

Visit www.ceb.cam.ac.uk

You will see things have slightly changed to make our website more appealing, user-friendly and help highlight the impact of our teaching and research activities. Please note the new purple colour theme; this reflects the more vivid and passionate direction that the department has taken since the Chemical Engineering merger with Biotechnology back in 2008. Department publications such as Graduate Brochure and *CEB Focus Newsletter* have also changed their overall look and now taken up the purple colour theme too … a sign of more exciting times ahead as the CEB New Building is under construction and our move to our new home on the West Cambridge site is expected in October 2015.

The University's Computing Service (UCS) helped CEB's Web Team with the design and structure of the new website whilst Phil Mynott took care of professional photography for our new online space.

It now falls onto the department members to help 'webmasters' keep consistently releasing content and themes that are useful to our current and prospect students, academics, alumni, corporate partners, sponsors and supporters, while simultaneously working on our own. Although we feel good about the fact that our website has the ability to facilitate content much better there is still room for further development and we are committed to keep working on it to improve your online experience whilst browsing our site.

If you have any questions or need help you can always contact the Web Team at webmaster@ceb.cam.ac.uk

CEB Learning and Teaching Review

Dr Patrick Barrie

The Department has been highly commended for the standard of its learning and teaching in a recent review by the University.

Every six years, the General Board conducts a Review of the Learning and Teaching taking place in each Department of the University. Last year was CEB's turn. The review panel consisted of an Oxford Professor of Chemical Engineering, Cambridge academics from the Departments of Physics, Engineering and Biochemistry, and a CUSU sabbatical officer. The panel read lots of paperwork and visited the Department in May when they quizzed staff and students about what we do.

First the good news in the resulting report.

"The Review Committee is impressed with the standards of the courses managed by the Department. The academic staff who attended the meetings are clearly highly committed to its teaching activities, and students are most enthusiastic and supportive of the Department and its teaching, administrative and resource provision. The quality of teaching is demonstrably at the highest level, and the teaching and research environments are clearly extremely positive and endorsed by staff and students."

Some other nice comments in the report are:

1. The committee was greatly impressed by the sense of energy and commitment in all groups addressed.
2. Students, both at graduate and undergraduate level, feel themselves to be well supported and represented by the Department.
3. Graduate students were particularly enthusiastic and positive about the support of the Department in fostering a lively and collaborative research environment.
4. The committee commended the unique opportunities provided to students taking the M.Phil. in Bioscience Enterprise.

Dr Patrick Barrie, Director of Teaching, doing what he knows best

The following are identified as particularly good practice:

1. The industrial links via the Teaching Consortium.
2. The Design Project at the end of CET IIA for bringing together the entirety of academic work in CET I and CET IIA, and affording students a great sense of achievement.
3. The 'Effective Researcher' two-day residential course for new PhD students.
4. The opportunity afforded to students to discuss their research work through presentations.

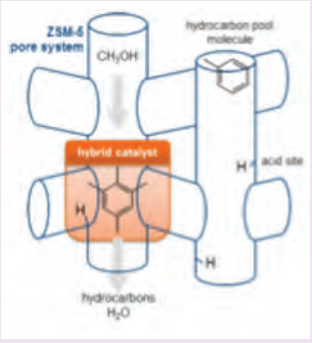
As is the nature of these reports, there was some less good news. The review panel made 17 recommendations. Most of these are concerned with governance and management procedures within the Department, though a few are directly connected with teaching. The recommendations aren't secret – they have been considered by various committees, including those with student representation – and progress is now being made on these.

Overall, the outcome of the review is very pleasing and external recognition that, by and large, we're doing a Very Good Job.

A New Perspective of Coke

James Erikson, PhD student, Catalysis Group

Catalysis is ubiquitous in industrial chemical processes, having huge economic importance while also being fundamental to achieving the goals of green chemistry and sustainability. Deactivation, e.g. due to carbon deposition (coke), is one of the major challenges facing catalyst development. Understanding how catalyst properties influence coke formation and the effects of coke on catalyst performance is the subject of extensive research. Advances in this area of knowledge will aid the design of catalysts with enhanced activity/selectivity and longer lifetimes.



Schematic diagram of a hybrid catalyst

The aim of my PhD project is to contribute to a new perspective of coke, where the carbonaceous species formed during reaction are not solely detrimental to catalyst activity but can in some cases contribute to the desired conversion and selectivity. This will be achieved by studying a selection of catalytic systems where coke plays different roles; alkane cracking and methanol conversion over zeolites, and alkane dehydrogenation over supported metal oxides. Apart from catalyst testing using a fixed-bed reactor, a variety of techniques will be used to characterise the catalysts and coke, including infrared, Raman, solid-state NMR and terahertz spectroscopies, temperature-programmed desorption and tapered element oscillating microbalance methods. A further aim is to develop methods by which to gather *in situ* data from these techniques. The first system being studied is the conversion of methanol to hydrocarbons over ZSM-5 zeolites, where a "hybrid catalyst" comprised of zeolite acid sites and hydrocarbon species formed during the initial reaction stage is responsible for activity. This work is generously sponsored by Johnson Matthey plc.

Biopolymer Based Delivery System for Mammalian Cell Bio-preservation: Alternative Non-toxic DMSO Free

J. A. Ocampos, K. Mahbubani, N.K.H. Slater, BioScience Engineering Group

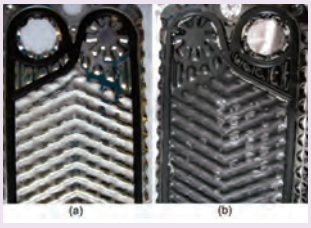
Many cell-based applications have arisen in recent years because of the increase of the aging population and the consequent high demand on healthcare treatments. Those application fields require reliable preservation systems that guarantee high cell viability after preservation, with predictable recovery of normal cell functionality. However, to date those conditions are not often accomplished and hence the requirement for improvements or changes in their preservation protocols. The only cell protectant technology that provides reliable long-term cell stabilization is cryopreservation, using temperatures below -80°C to minimize degradation. This process is traditionally accomplished using high concentrations of permeant cryoprotectant agents (CPA). This technology presents several limitations that have stimulated the search for improvements in bio-preservation.

The aim of this study was to investigate a polymer-based delivery system for its application in bio-preservation of nucleated mammalian cells, by delivering the trehalose into the cells. Studies have been made in the main parameters involved in the proposed system to improve cell viability and cell recovery. Viability measurements of cells incubated at different concentrations of trehalose / polymer solutions were taken during incubation. Improvements have been made to the incubation protocol to achieve the highest cell viability, cell integrity and highest recovery of cells after freezing and thawing protocols. Experiments have been conducted in CHO cells, HeLa cells and K562.

A Techno-Economic Analysis of the Performance of Antifouling Coatings in Heat Exchangers

Leonardo Gomes da Cruz, visiting scholar in Paste, Particle and Polymer Processing Group, University of São Paulo, Brazil

Fouling is a widespread problem in heat transfer systems and necessitates regular cleaning. The use of inert, 'antifouling' coatings has been proposed as a mitigation strategy for the problem. Figure 1 shows milk fouling layers on a standard stainless steel plate and one coated with diamond-like carbon (DLC). Although the DLC coated surface looks attractive, it must be good enough in performance and return on investment in order to replace existing devices. The aim of this project is to evaluate just how good the coating must be before a plant would consider using it.



Milk fouling on heat exchange plate: (a) stainless steel plate; (b) DLC-coated plate

We have performed techno-economic analyses of the antifouling coatings, using experimental data reported in the literature. Surface treatments considered including diamond-like carbon, perfluoropolyether and nickel-polytetrafluoroethylene. Collaborators at the Technical University of Braunschweig have supplied operating data and experimental results.

Fouling and cleaning cycles have been considered for two important industrial cases: water scaling in shell-and-tube exchangers, and milk pasteurization in and plate heat exchangers. A series of optimisation calculations are performed, as fouling incurs costs due to reduced heat transfer, and cleaning itself is expensive and generates significant costs in disposing of cleaning chemicals. The results allow the impact of an 'antifouling' coating to be assessed and the benefit margin quantified. A scholarship from the University of São Paulo is gratefully acknowledged.

Carbon Nanotube Super-capacitors

Hongkai Ma, Electrochemical and Micro Engineering Group

Supercapacitors, namely electrochemical capacitors or ultracapacitors, are capacitors with great capacity. Compared with conventional capacitors, supercapacitors have higher capacity due to their higher surface area electrode materials and thinner electrolytic dielectrics. From the literature, supercapacitors exhibit 20~106 times of capacitance than that of conventional capacitors. Thus, its higher power density, lower internal resistance, faster charge and discharge ability, and better reversibility have attracted much attention by researchers in recent years.

Bag-cell super-capacitor

Super-capacitors can be divided into three categories, double layer capacitors, pseudo-capacitors and hybrid capacitors. Carbon materials, such as activated carbons, carbon aerogels and carbon nanotubes, are the electrode materials for double layer capacitors; conducting polymers and metal oxides are the materials for pseudo-capacitors; hybrid capacitors are the composite of these two capacitors. The work I have done about the use of electrochemical systems in characterisation of an innovative electrode material and an ultrathin super-capacitor with aligned carbon nanotubes electrode. The copper foil is used as the substrate on which the carbon nanotubes grow with specific circumstance. Ultrathin super-capacitor was successfully fabricated as a bag cell, which possess advantages of smaller size and easier to operate. The Cu-CNTs samples that we used present good capacitive property. We have consequently illustrated a method to manufacture Cu-CNTs, as well as a process to fabricate the ultra-thin devices, and believe that this represents a promising way to meet future energy demands.

Computer Algebra Systems Coming of Age: Dynamic Simulation and Optimisation of DAE systems in Mathematica™

A.K.W. Navarro, V.S. Vassiliadis, Process Systems Engineering (PSE) Research Group

1. Introduction: Process Systems Engineering

Process Systems Engineering (PSE) is a specialization area within Chemical Engineering that studies processes from the systems point of view. The key aim is to study physicochemical as well as logistics processes in order to model them and to then apply simulation and optimization tools to design and operate them in an optimal way. This implies usually utilization of economic objective criteria to be minimized or maximized.

PSE focuses on three aspects of the modelling process. The first aspect is to identify if an *application* will benefit from rigorous modelling with a view not only to design processes but to also understand the underlying mechanisms. The second aspect is model *formulation*, once the basic physics of an application are understood. There may be more than one way to model a given system and the best model is the one that suits the purpose. Usually there is a trade-off between efficiency of model solution versus accuracy and fidelity of the model. A very exact and fully detailed model may take very long execution times and may require highly sophisticated algorithms, or at the extreme may be intractable computationally even with the best of available solution methods. The final and third aspect is the identification of the most suitable *algorithm* to solve the model, either for simulation or optimization purposes. Depending on the model there is usually a range of algorithms that can be used. Difficult and highly complex formulations will require advanced solution methods if one is to guarantee the quality of the solutions obtained.

2. DAE Systems and Computer Algebra platforms recently accepted publication

The paper we produced in our group focuses on the important issue of simulating and optimising process models involving Differential-Algebraic Equations (DAE's), which is a generalisation of describing dynamic models (typically described by Ordinary Differential Equations). The paper was accepted **without any correction or revision requirements** immediately by the journal Computers and Chemical Engineering, which is fairly unusual in the review process and we feel it demonstrates the very high quality work done in the PSE group.

In this work we present two packages developed in our research group, DAEparser and SQPSolver, developed within in Mathematica™. These packages joint capabilities for dynamical system analysis, simulation and dynamic optimization through the direct sequential approach (which addresses the issue of optimal control problems) are presented with examples and case studies highlighting applications of practical interest to chemical engineers. An overview of the relevant theoretical topics to each of the features of the packages are presented as well as implementation insights. This work paves the way for innovative R&D platforms both capable of solving practical problems of interest as well as offer seamless computational workflow. The paper was accepted in one go by the journal, receiving comments like:

"Your manuscript is acceptable in the form submitted and has been forwarded to the publisher. No further action is required on your part until you receive proofs from Elsevier."

"This article is concerned with DAE parser and SQP solver for Mathematica, which have been demonstrated to be used for dynamical system analysis, simulation and dynamic optimization with a set of representative chemical engineering examples."

"A nice overall paper that covers in a convincing way the mathematical analysis of dynamical systems and their implementation."

The paper presents a complete overview of DAE models and the aspects of interest to practicing engineers, namely: (a) structural properties of DAE systems, (b) integration of such systems, (c) steady-state identification and stability, (d) sensitivity analysis evaluation (of importance for example in chemical kinetics studies), and (e) dynamic optimisation of DAE models (optimal control). Importantly what was also addressed in this work was a standardisation of model description in symbolic form so as to render models

re-usable and maintainable with ease. The use of a Computer Algebra System (CAS) such as Mathematica™ was demonstrated to offer a unique platform to describe and analyse process models. The tools presented also offer a unique solution to academic and small-to-medium scale industrial R&D applications as they require no expensive licenses and they already are within a platform that allows the model simulation and optimisation to be a small part of a potentially much larger computational task. Carrying out the work for example in Mathematica™ was demonstrated to allow a seamless workflow for fairly complex computational tasks.

3. Application examples

The first example presented is the optimal control of a batch distillation column involving a 5 hydrocarbon mixture and a column of 20 trays (Costra Jr., *et al.*, 2003). The model is given in Figure 1. It structural analysis results by DAEParser is given in Figure 2. The solution of this problem was found to be in excellent agreement with the literature reported results.

$$\frac{dn_{1,j}}{dt} = V_2 y_{2,j} + (1+R_R) L_1 \frac{n_{1,j}}{M_1} \qquad j = 1,\ldots,5$$

$$\frac{dn_{i,j}}{dt} = L_{i-1}\frac{n_{i-1,j}}{M_{j-1}} + V_{i+1}y_{i+1,j} - L_i\frac{n_{i,j}}{M_i} - V_i y_{i,j} \quad i = 2,\ldots,19;\ j = 1,\ldots,5$$

$$\frac{dn_{20,j}}{dt} = L_{19}\frac{n_{20,j}}{M_{19}} - V_{20}y_{20,j} \qquad j = 1,\ldots,5$$

$$M_i = \sum_j^5 n_{i,j} \qquad i = 2,\ldots,20;$$

$$y_{i,j} = K_{i,j}(T_i)\, x_{i,j} \qquad i = 2,\ldots,20;\ j = 1,\ldots,5$$

$$1 = \sum_j^5 y_{i,j} \qquad i = 2,\ldots,20;\ j = 1,\ldots,5$$

$$L_i = \beta_0 \left(|M_i - ML|\right)^{1.5} \frac{(1+\tanh[M_i - ML])}{2} \qquad i = 1,\ldots,19$$

Figure 1. Batch distillation dynamic model

```
DAE MAIN PARSER ROUTINE ENTERED

Problem Name = batchDistSimple_03
Solve Option is = DynamicSimulation

DYNAMIC MODEL COMPILATION FOR DYNAMIC SIMULATION.
Number of model construction parameters = 26

Number of DAE's = 254
Number of Initial Conditions = 101
Number of differential state variables ("x") = 101
Number of algebraic state variables ("y")= 153
Number of structural model parameters ("p") = 40

Jacobians will be stored.

Entering model structural analysis.
```

Figure 2. Batch distillation dynamic model structural analysis by DAEParser

Another example involves the optimal control of a bioreactor producing penicillin (Riascos and Pinto, 2004). The DAE model for the process is given in Figure 3. The optimal solution obtained is shown in Figure 4, with biomass shown as the dashed line and th product concentration as the full line.

$$\dot{X} = \mu X - \left(\frac{X}{S_F V}\right) U$$

$$\dot{P} = \rho X - K_{deg} P - \left(\frac{P}{S_F V}\right) U$$

$$\dot{S} = -\mu\left(\frac{X}{Y_{X/S}}\right) - \rho\left(\frac{X}{Y_{P/S}}\right) - \left(\frac{m_s S}{K_m + S}\right) X + \left(1 + \frac{S}{S_F}\right)\frac{U}{V}$$

$$\dot{V} = \frac{U}{S_F}$$

$$\mu = \mu_{max}\left(\frac{S}{K_x X + S}\right)$$

$$\rho = \rho_{max}\left(\frac{S}{K_p + S(1 + S/K_{in})}\right)$$

Figure 3. Bioreactor dynamic model for the production of penicillin

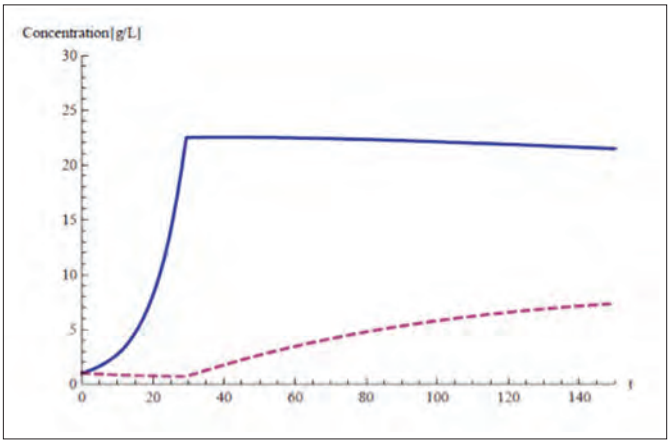


Figure 4. Bioreactor optimal state profiles for the production of penicillin

References

E. F. Costa Jr., R. C. Vieira, A. R. Secchi, E. C. Biscaia Jr., Dynamic simulation of high-index models of batch distillation processes, *Latin American Applied Research* **33** (2) (2003) 155-160.

C. A. M. Riascos, J. M. Pinto, Optimal control of bioreactors: a simultaneous approach for complex systems, *Chemical Engineering Journal,* **99** (1) (2004), 23-34, ISSN 1385-8947, doi:10.1016/j.cej.2003.09.002, URL http://www.sciencedirect.com/science/article/pii/S1385894703002535

CEB Scientist takes US Market by Storm with Camel Milk Cosmetics Venture

A native of Jordan, Penelope Shihab overcame obstacles to establish a high-science biotech company in the Muslim country. Now, she is growing the U.S. spinoff at the University of Missouri Life Science Business Incubator

Penelope Shihab, Antibody Production company MONOJO's CEO and Founder, is not only an ambitious scientist and mother of four with an entrepreneurial streak, but also most certainly a role model to follow in her native Jordan, Middle East and the rest of the world. She previously gained a Bachelors Degree in Medical Biotechnology from the Applied Science University in Jordan. Penelope is a member of local societies and has more than 12 years of management experience. Her work supports the innovative applied research across diverse sectors such as healthcare, economy and industry.

However, her entrepreneurial road has not been a smooth and easy one to travel on as one would have thought, having to face many challenges along the way. Although she leads a very hectic lifestyle, the CEB Focus Team had a chance to briefly catch up with this hugely talented lady, who is currently in the middle of a US tour promoting her own exciting commercial venture, SKINUE, a company focused on the production and sales of camel milk bio cosmetics.

Penelope set up MONOJO back in 2005 with an aim for it to become a leader company in Biotechnology. The company now epitomises the new concept of knowledge-based economy. MONOJO in Jordan is where the main company's R&D is located. MONOJO's first subsidiary in US 'Columbia Biotech' is a complementary for MONOJO's R&D department encompassing its business development and marketing operations for its innovative bio-products. MONOJO strives to transfer its applied research in biotechnology to serve the world with unique biological products that have a major impact on people's lives, worldwide environment and economic well-being.

She tells us about the positive impact of her time spent as a visitor at CEB's Institute of Biotechnology; *'I started working with Professor Chris Lowe back in 2007; we signed a Memorandum of Understanding (MoU) for joint research leading to a PhD students and scientist exchange. The University of Cambridge, being number 1 in the ranks, and Chris' track record, being one of the top ten pioneers in biotech field worldwide, really boosted our credibility'.* Incidentally, CEB's Biotechnology Professor Chris Lowe happens to be on MONOJO's Board of Directors.

With regards to MONOJO's foundations and her collaboration with Cambridge Pen adds; *'As well as being my advisor and MONOJO Board member, Professor Lowe has also been a mentor and a friend. Over the last five years he has supervised my research at MONOJO and also given me guidance and assistance with all ongoing projects there'.* She admits that Professor Lowe's guidance and encouragement, in addition to her exposure to advanced research in Cambridge, helped her set up MONOJO. More specifically, the Scientist Exchange Programme between Cambridge and Jordan has successfully helped introduce MONOJO's team globally. *'I personally think that Cambridge has helped bridge the gap between East and West, giving me the confidence to be a great scientist and the motivation to move forward in this field';* she states.

Her past, culture and time in Cambridge clearly had an impact on the birth of Pen's camel milk business idea. She comments; '*Bedouins have used camel milk intensively in folk medicine to treat challenging diseases like cancer and many infectious diseases. The protein in camel milk has natural antibodies, which are very stable against high temperatures and acidity. It can also fight many viruses. In a process discovered and developed in MONOJO, the camel was triggered to produce antibodies for specific microbial infections with minimum side effects, unlike typical antibiotics that could harm body organs and body natural flora'.* She adds; *'SKINUE is our first skin care product line, both created and recently launched in the US. The cosmetic products have been developed using enhanced camel milk. It is a natural, safe and effective*

solution for acne problems, in addition to other medicines available in the market. What I really wanted to do with SKINUE is change scientific research culture in Jordan. Researchers there are only mainly concerned about promotion but I wanted them to think in economic terms and become more business-oriented. If I'm successful with my R&D to market idea, scientists will definitely realise their knowledge power as well as its positive financial impact on their lives and the country's economy. She continues; 'MONOJO is a role model intended to show knowledge power. Following its success penetrating the American market I now believe many innovators will follow our business model. We also offer mentorship, guidance and incubation facilities. My team of scientists at MONOJO are interested in incubating innovative ideas and then converting them into real products or technology'.

© Don Shrubshell, Columbia Tribune

Khaled Al-Qaoud, R&D Manager at MONOJO, (left) discusses the results of a protein separation process with Khaldoon Al Qawasmeh, right, a senior researcher and protein purification specialist

Pen's passion shines through revealing that behind her business mission there is a hidden cause very close to her heart, her inspiration and the key to her personal development. She explains further; *'I was my mother's dream one day, she always dreamed of seeing Penelope as a strong, highly educated leader ... and I achieved my mother's dream. Now, I'm dreaming, I dream about becoming a global entrepreneur recognised for her achievements in business and science. I'd like to motivate others to create new biotech companies in the Arab region. I work hard to improve people's quality of life, that's the main reason I created my brand SKINUE to enhance people's beauty, make them more confident with their appearance and introduce highly-effective, authentic and affordable cosmetic products. Also, I have investors who have been patient enough over the last 8 years of research and product development. They understand my challenges and I highly value their support so I'd like to achieve profitable sales to satisfy them',* ambitious Pen mentions.

MONOJO business venture has undoubtedly highlighted Pen's personal aims: *'We have to create opportunities not only spot opportunities - my great mentor Dr Samih Darwazah keeps telling me - Penelope, you go and create your luck as no one cares about your good fortune'.* She adds, *'He believes in what I do and said that he would keep supporting me even if my research gave zero results. I fully believe that having a wise mentor, in addition to surrounding yourself with business experts, will certainly help you achieve your goals. My main aim is to take MONOJO from a local start-up company to a worldwide successful biotech company. With MONOJO, I envision building an innovative biotech sector in the Arab region'.*

MONOJO set up its subsidiary operation in US and has just launched its first commercial product in the US market: SKINUE, a line of bio-cosmetics and skin treatments containing proteins from camel milk. CEB Focus Team, fascinated by the fantastic science behind MONOJO, wanted to know more about its applications. Pen has now revealed that three patents have been filed for MONOJO products in the US and recently also in the UK.

In addition to SKINUE, MONOJO has several other innovative projects in the pipeline all aimed at delivering bio solutions to worldwide challenges focusing on:

1- Novel antimicrobial compounds (natural extracts)
2- New anticancer active leads (synthetic chemical entity)
3- Antibody-based Cancer Biomarkers (tumour markers for diagnostic applications)
4- Innovative Biosensors (HbA1c sensor biological based analyser)
5- Hybridomas and Antibodies

On a different matter, Pen admits that raising support and funding for a biotech start-up in Jordan has been challenging; *'Our biggest challenge during the first 5 years was acquiring enough funding and support for MONOJO to expand. Initially, I got seed funding from NGO's like US AID, European Commission (EC) and JICA, in addition to funding from local government institutions such as The Higher Council for Science and Technology (HCST) and The Royal Scientific Society (RSS) in Jordan,*

local universities like the University of Jordan and Philadelphia University, in addition to individual investors. Persistence and targeting the right people who believe in the future and potential of biotechnology is vital'. Over the last 3 years Dr Samih Darwazah, founder of the Jordan based multinational pharmaceutical firm HIKMA.com (listed on London stock market), has willingly invested in MONOJO, fully supporting a female-led company in the biotech sector.

MONOJO Chief Executive Officer Penelope Shihab, left, speaks with the company's research and development manager, Khaled Al-Qaoud, at MONOJO's headquarters in Amman, Jordan

Still, Pen has had to overcome a series of hurdles and barriers, and not only in the initial stages of start-up! She explains; *'The main problems are fundraising and convincing the business sector of the importance of biotechnology for the country's development. In addition, being a female entrepreneur in a Muslim culture that is still very much male-dominated is hard. Women have fewer opportunities to leave their house to go to work. A woman aspiring to acquire higher scientific degrees and/or approaching potential investors to help launch biotechnology start-ups is still very much frowned upon. However, I also must say that I would not be where I am today without my husband Ammar. He has given me his full support as well as my family, certainly my mother, who takes care of my kids while I'm travelling'.* She continues; *'There are also other basic challenges involved in starting up a new company such as team building, managing, planning, etc…'* She adds; *'It is not easy to invest in the biotech sector in the Middle East because it is an immature market. Jordan has highly educated people, who are a big asset but, unfortunately, this is not properly exploited mainly due to the lack of entrepreneurship spirit and governmental support. I believe that until the new generation leads change in all sectors including biotechnology, we will be working hard to educate investors with real success stories like MONOJO'.*

As per things on the home front, juggling a hectic lifestyle as a scientist, entrepreneur and company CEO with being a wife and full time mum to four children cannot be an easy task. She proudly says; *'I run both companies as well as the family. I still have a husband and four children at home. The biggest challenge now is balancing my time between running the company in Amman, which also does contract research for other companies, and the fledgling US operation. I'm a very ambitious, adventurous person, very sociable and love to meet new people and exchange cultural interests. When I started my career back in 1997 and got married at the same time, one of my great successful friends told me: 'When you have kids you need to give them quality time not full time, you need to raise them as independent, be their role model rather than pushing them to be successful'. And that is exactly what I did, my kids are very responsible like me and they work hard to keep the family happy despite all of the challenges we face. I used to take one of my kids along with me whilst travelling and that made a huge difference in his life because he attended some of my meetings and gave him a chance to talk to different people and explore new worlds. I love travelling, sports in general and sport cars. I'm also a strong believer in Islam as a great religion, but I also respect all the others as have friends from different backgrounds and religions and I enjoy diversity. I feel very international myself, especially having spent time in Cambridge doing summer courses and research, and also in US setting up my company'.*

MONOJO's operation in the US, Columbia Biotech is her US venture housed in the University of Missouri Life Science Business Incubator. Pen confirms; *'Columbia is the first testing market and will build a value for the product line. I headed to the US for many reasons, mainly because there are more funding opportunities for the biotech start-up companies there. I have well-established business contacts in the US, where local culture values trust cosmetic products more. Therefore, these products are more successfully marketed in the West than the East'.*

Finally, as per her next chapter in life and future entrepreneurial adventures, Pen comments; *'I am a serial entrepreneur so I always have a new dream in the pipeline. I will keep you posted on my new goals'.*

(Sources: www.monojo.com.jo and www.skinue.net)

Innovation Leaders Land in Cambridge 27 – 28 Feb 2014

Ning Xiao

Innovation happens when brilliant minds come together. At the Innovation Leaders Conference, we seek to promote the translation of cutting edge research into leading products and services by building bridges between academia, industry and government and linking innovative minds across disciplines.

Hosted by the Innovation Forum, a network of multidisciplinary innovative talent based at the University of Cambridge, the Innovation Leaders Conference takes place at Clare College, Cambridge on the 27 and 28 February 2014 brings together 300 academics, business leaders, disruptive entrepreneurs and venture capital to stimulate communication and catalyse partnering for the next generation of innovative technology.

The two-day meeting in Cambridge will combine:

- **Insight keynote lectures** from leading R&D executives and eminent academics including Professor Sir Leszek Borysiewicz (Vice Chancellor, University of Cambridge), Professor Sir Greg Winter (Master of Trinity College, Cambridge), Professor Chris Lowe (Director, Institute of Biotechnology, University of Cambridge), Professor John Davidson (Emeritus Professor, Department of Chemical Engineering and Biotechnology, University of Cambridge), Patrick Verheyen (Head of Johnson & Johnson Innovation Centre London), Dr Jane Osborn (Vice President Research and Site Leader, MedImmune).

- **Panel discussions** on academia-industry partnerships and true open innovation featuring Professor Nigel Slater (Head of Department of Chemical Engineering and Biotechnology, University of Cambridge), Professor Shankar Balsubramanian (Illumina inventor; University of Cambridge), Dr Tim Minshall (Lecturer in Technology Management, University of Cambridge), Dr Shai Vyakarnam (Director, Centre for Entrepreneurial Learning, JBS, University of Cambridge), Helen Goulden (Executive Director, Innovation Lab, Nesta), Martino Picardo (CEO, Stevenage Bioscience Catalyst), Antony Mattessich (CEO, Mundipharma).

- **Technology Innovation Showcase** featuring Cambridge University's innovative research projects with high commercial potential.

- **Workshops** and **focused discussion groups** by industrial leaders.

- **Exhibition** of companies' innovative products and services.

To register please visit www.inno-forum.org

Great thanks to CEB for supporting the Innovation Leaders Conference, Ning Xiao, CEB's PhD student and Innovation Forum Vice President commented on the Innovation Leaders Conference vision and support from CEB and other industrial sponsors; *'Innovation Leaders Forum is trying to bridge the gaps among academia, industry and policy making, and through doing so to search the most innovative solutions and make impacts on global problems in life science, engineering, as well as energy. As the Vice President of the conference organising student society, Cambridge University Innovation Forum, I want to express my highest appreciation for the support from our department. There are a lot of people in our department making a great contribution to impact on this conference. Professor Nigel Slater (HoD) is chairing the panel discussion, Professor John Davidson Emeritus Professor, and Professor Chris Lowe (Director of Institute of Biotechnology) will give keynote lectures and Professor John Dennis will chair the Energy Panel Discussion'.*

Taking Chemical Engineering out of the Classroom and into Consulting

There are a lot of options for a Chemical Engineering graduate: the skills that you learn are valued not only by engineering employers but also across sectors including financial services, management and information technology. I was aware of Arthur D. Little's image as a consultancy firm that adds real value based on a deep understanding of technical issues combined with innovation. I was particularly interested in the Arthur D. Little Risk Practice, based in Cambridge, due to the worldwide, cross sector nature of their work and closer affinity to Chemical Engineering.

I joined the Risk Practice shortly after graduation and have since gained experience across different industries and functions on projects that utilised my engineering training and developed my skills. To date, I have been involved in projects in transport, construction, utilities, food and beverage, and process sectors. Our work often involves solving challenging problems for clients where more conventional solutions have failed and one of the most rewarding aspects is being able to see the positive impact of our assignments on client organisations.

We have clients all over the world so I have also been able to fulfil my ambition to travel. Recent assignments undertaken by the Risk Practice team have included time spent in Dubai, Hong Kong and Mozambique. Not only is this a great opportunity to work with clients from other cultures and see some amazing places, but as Arthur D. Little actively encourages employees to have outside interests, I even managed to learn to scuba dive at the weekends during a trip to Cuba! We differ from many of the other well-known management consulting companies in that our teams typically mobilise from Cambridge to deliver assignments for relatively short periods of time in other countries. However, teams are not left in-country for many months, as the company feels that regular time spent in our home office is important to team cohesion and quality of life, and we also have many projects in the UK.

Two particularly memorable assignments for me have been a HAZOP (HAZard and OPerability study) in Cuba and a risk assessment for an international train operating company. We were working on a refinery in Cuba for four weeks, with a team of operation and design engineers, to fully understand the process and ensure that it was safe and operable. The risk assessment for an international train operating company was a very different kind of project. The rail industry was not something that I had covered as an undergraduate, but the underlying skills from the course, such as logical problem solving, proved a good starting point.

Muirgan and George, two recent recruits of Arthur D Little

Arthur D. Little recognises that future success is built on hiring the right people who are willing to commit to careers with the Risk Practice. If this type of graduate role sounds appealing, please feel free to get in contact. Our team continues to look for high quality recruits.

More information about careers on www.adlittle.co.uk

Arthur D Little, former member of the Teaching Consortium companies (TC), has recently rejoined. Furthermore, the other TC companies have renewed their membership. If interested in becoming a TC member visit www.ceb.cam.ac.uk/enterprise/partnership-opportunities

Masters in Bioscience Enterprise Success Story: Desktop Genetics

Jantine Broek

Desktop Genetics (DG) is one of several success stories of CEB's MBE course students. It was established by Riley Doyle, Victor Dillard and Edward Perello. DG is a biotechnology company specialised in DNA design, synthesis, management and sharing. Their platform, AutoCloneTM, is a DNA search engine that enables more efficiency in genomic research. CEB Focus asked Victor Dillard how they established such a successful company.

- **What is your main business product?**

The main product behind DG is an automated software platform that enables the optimal design, construction, management and exchange of DNA constructs. This tool is unique and powerful and facilitates some of the most frustrating challenges facing researchers today.

- **How did you get the funding to set-up DG?**

DG started with the £7.5k won at the final stage of the Cambridge University Entrepreneurs (CUE) competition. A few months after incorporating DG, we were selected to join the Healthbox accelerator programme, which gave us capital, along with space and mentorship, develop a prototype product, meet with a large number of customers, study the market in more detail and raise successfully our first round of financing.

- **How did you prepare to pitch your ideas to potential investors?**

Preparing the pitch to investors is about being clear, concise and focused. If your friends, parents or teachers don't get it, neither will the investors. Keep the answers to their questions focused and to the point. Your goal is to walk away with a concrete next step, whether this is a "not interested, move on" or "sending over a termsheet".

- **During your MBE course, how did you manage to create value for your idea and a future business?**

During the MBE, we had the unique opportunity to easily connect to almost anybody. The most value-creating activity we could do was to network with industry professionals, researchers, academics and investors, and focus on building our professional network. When you are a student, everybody is extremely open to speak with you about your ideas, unfortunately this changes when you leave school and incorporate your company and it becomes significantly harder.

- **What is DGs ultimate goal?**

The ultimate goal of DG is to make a positive impact on biotech research. Our mission is to enable researchers with the right software tools required to carry out better, faster and more efficient research.

Desktop Genetics creators from far right to left Victor Dillard, Edward Perello and Riley Doyle giving a talk to the MBE students

Athena Swan at CEB Presses forward

Dr Krish Mahbubani

Athena SWAN awards recognise and celebrate good practice in recruiting, retaining and promoting women in STEMM in higher education. There are currently 95 member institutions and 259 award holding departments. The department aspires to join these ranks and has begun the steps in becoming a bronze award holder of this charter.

In order to achieve the award, the department must show that it fulfils their gender duty commitments, work towards sustaining equitable working environments and enable them to identify themselves as employers of choice, not only to their staff, but to students, funders, research councils and industry.

Gathering information between the three sites and finding a suitable benchmark for the statistics has been somewhat of a challenge but puts us in a unique position to showcase the department's potential through the integration of these sites.

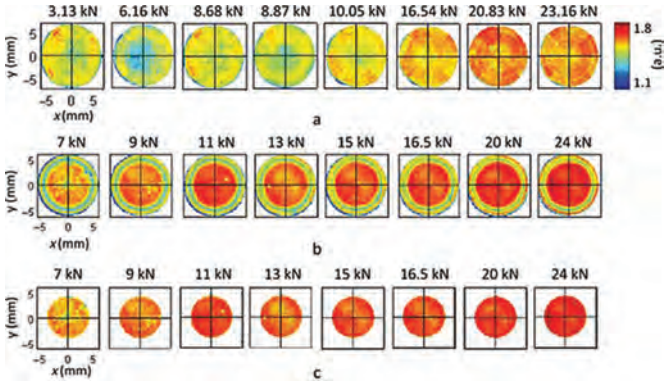
Currently, we are evaluating how well we have been performing, ensuring that we identify challenges and highlighting opportunities where improvement can be made as well as putting actions into place for progressive transformation ensuring a gender balanced environment at a high scientific level. The findings to date are very encouraging as we stand out as being above the national average in terms of female applicants both at undergraduate and PhD level as well as in performance values (undergraduate grades). We stand out even further in our ability to retain and promote female students when compared to the department of Engineering.

The next step will be to focus on the staff data, and in recent years, recruitment and retention of female lecturers has been on the increase. The team, headed by Sarah Rough, are pressing forward and aiming to submit the application for consideration at the end of April 2013.

Editors' Choice Paper

A paper published by the Terahertz Applications Group earlier in the year was selected by the editors of the Journal of Pharmaceutical Sciences as their pick of the most original and most significant scientific findings published in the preceding three issues (July 2013 - September 2013).

The featured paper is **Hardness and density distributions of pharmaceutical tablets measured by terahertz pulsed imaging,** *by Robert K. May, Ke Su, Lianghao Han, Shuncong Zhong, James A. Elliott, Lynn F. Gladden, Mike Evans, Yaochun Shen, J. Axel Zeitler,* Journal of Pharmaceutical Sciences, Volume 102, Issue 7, pages 2179–2186, July 2013.



Terahertz surface refractive index maps of biconvex (top) and flat faced (bottom) tablets compacted at different compression forces.

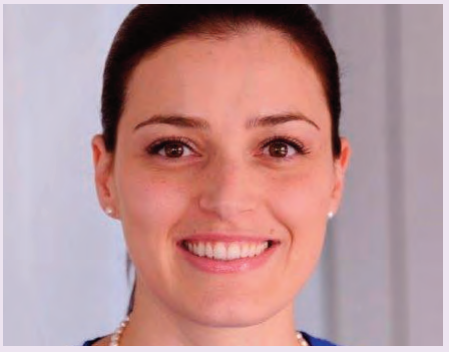
Carpe Diem Bursaries Awarded to MBE Students

For the second year, the Carpe Diem Enterprise Trust has awarded educational bursaries to support the studies of three students of the Master's in Bioscience Enterprise Programme 2013-14. The recipients are:

- **Daniel Lopez-Martinez**, who graduated with a degree in Biomedical Engineering from Imperial College, London and conducted research internships at Harvard, MIT and Oxford before joining the department.
- **Dr Milla Marinova**, a doctor at Chelsea & Westminster Hospital, London, who also has an interest in International Health Policy, which she studied at postgraduate level at the London School of Economics.
- **Michael Anderson Burley**, who worked in the business development team at the Joint Bioenergy Institute, San Francisco, USA after graduating in Biotechnology from Imperial College, London.

Michael Anderson Burley

Daniel Lopez-Martinez



Dr Milla Marinova

The award holders in 2012-13 were highly successful trailblazers for the charity, with one of their number, Dr Darryl Gibbings Isaac, achieving the MPhil degree with Distinction and taking the RSA Award for the best performance in the dissertation aspect of the programme.

Biotechnology alumnus Dr Darrin Disley (PhD Biotechnology 1991-96) is a serial business entrepreneur in the Biotechnology sector. Currently, he is the CEO of Horizon Discovery Ltd, which is a UK translational genomics company. Professor Chris Lowe, Darrin's former PhD supervisor commented; *"It is a humbling experience to see my ex-PhD student become the CEO of one of the fastest growing biotechnology companies in Europe, Horizon Discovery, which was recently named the East of England's Business of the Year and was conferred with a Queen's Award for Enterprise in International Trade. Darrin's extraordinary capacity to engage in corporate development, business strategy and investor relations, as well as raising finance and closing deals, has resulted in treble digit percentage growth of Horizon over the last few years. We are extremely honoured and pleased that Darrin supports our Master's in Bioscience Enterprise Program as a lecturer and sponsor and imbues our cohort of up-and-coming young bio-entrepreneurs with his special magic".*

Biotechnology Alumnus Dr Darrin Disley

Darrin Disley granted the bursaries to MBE students through his Carpe Diem Trust, and mentioned; *"I am honoured to be associated with the Masters in Bioscience Enterprise Program. Through my role as Enterprise Fellow and the funding of education bursaries via the Carpe Diem Enterprise Trust, I endeavour to support and nurture a new generation of life science entrepreneurs able to translate technological innovation into the exponential increase in industrial productivity needed to drive the global economy over the next 50 years".*

Department Events Lent Term

Social events
Undergraduates: CUCES on Facebook
www.facebook.com/groups/121361787936091/ - also see www.cuces.soc.srcf.net

CEB Party Nights
Join the group www.facebook.com/groups/cebpubnights
for updated information on Department social events and regular pub nights. It is a group open to all post-grads, post-docs, researchers, and whoever works in the Chemical Engineering and Biotechnology Departments.

CEB Career Talks

This initiative launched in Michaelmas Term and has now replaced the former 'Alumni Speaker Series'. Talented graduates come to the department to share their expert knowledge and valuable insights into their chosen careers. Professional leaders in key industry and academic positions in the CEB alumni community are also hugely knowledgeable in their fields of expertise. Graduate experience can be an invaluable source of career advice to our students as they search for valuable information to help them make better informed decisions about the career choices available to them.

Following the career talk there will be a networking session over drinks and nibbles to allow students to ask alumni more specific questions in an informal setting. This will also allow students to connect with graduates, who will in turn have the opportunity to re-connect with their department and their alma mater. For more information, to contribute or suggest particular career fields, contact Elena Gonzalez, PA to HoD, on eg314@cam.ac.uk

When/Where: Lunchtime Career talks twice a term at 1.15pm in Lecture Theatre 1, Shell Building, Pembroke Street site. (Sandwich lunch provided at 1.00pm)

Purpose: These talks are aimed for the benefit of current undergrads and also more mature students including early career researchers. These talks are organised to help them get a better understanding and taste of what it's like to work in different Chemical Engineering and Biotechnology fields.

Lent Term
- Thursday 4 February 2014 – Careers in Rail (Anthony Hyde)
- Thursday 27 February 2014 - Project Engineering in the Hygienic, biotechnology & Pharmaceutical process industries (Tim Oakley)

Easter Term
- Thursday 24 April 2014 Venture Capital (Stephen Capsaskis)
- Thursday 29 May 2014 Communicating Biotech and Life Sciences (Fay Weston)

CEB Seminar Series

Where: Pembroke Street site, LT1, 2.00pm
When: March 2014 dates to be confirmed
Contact Dr Bart Hallmark for further details on bh206@cam.ac.uk

Sir David Harrison appointed Chair of Diocesan Board of Education

Sir David Harrison CBE, FREng was a member of Faculty here teaching Chemical Engineering from 1961 until 1979 when he became a Fellow of Selwyn College in Cambridge and its Senior Tutor. He was also Chairman of the Government's Advisory Committee on the safety of nuclear installations. Sir David was knighted in 1997 and since his retirement he has remained extremely active and a big CEB supporter often involved with department development and contributing to alumni events.

Back on 3 September 2013 the Bishop of Ely announced that our very own Sir David had been appointed Chair of the Ely Diocesan Board of Education until September 2014. His appointment follows the move of the Bishop of Huntingdon to be the Acting Bishop of St Edmundsbury and Ipswich. He added; *'The Church of England is responsible for 82 Primary schools in the Diocese of Ely, with the majority in Cambridgeshire but some are in Peterborough and West Norfolk. Apart from chairing some meetings, my job is to support the 12-strong staff lead by the Director of Education, who is very experienced retired Schools Inspector. 2014 will undoubtedly be a time of challenge, and particularly to maintain high standards. About ten schools will be probably be awarded Academy status by the end of the year.'*

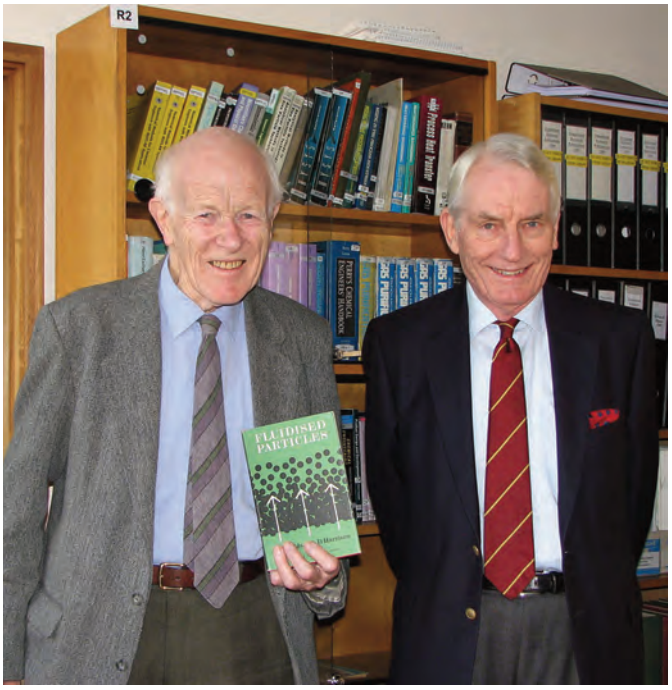
Nepal Scholar Visit

Dr Khanal

Dr Sumesh Khanal is usually based at the Institute of Medicine in Kathmandu, Nepal, however in recent months he has been sponsored by Costello Medical Consulting to undertake an internship in Cambridge. During his time as a Visiting Scholar at CEB's Institute of Biotechnology and with expert guidance from the Costello team, Sumesh has investigated the factors critical to the successful implementation of telemedicine systems in developing countries such as Nepal, and whether there is evidence to suggest telemedicine can really improve the problem of access to healthcare and cost of healthcare delivery in rural areas of low-income countries. Sumesh will be returning to Nepal this January to pursue his medical career. He aspires to specialise in public health with a particular focus on the opportunities telemedicine offers for patients residing in remote and inaccessible regions.

Costello's over-arching charitable aim in hosting a series of internships is to assist the delivery of effective healthcare globally by applying the company's knowledge to public health issues. The company, co-founded by Sophie Costello, an alumnus of the Master's in Bioscience Enterprise (MBE) programme in 2002-03, specialises in evidence-based medicine, medical communication and health economics. It now employs 45 people and has recently moved to larger premises on Hills Road, Cambridge. Professor Chris Lowe, MBE course Director, states; *"It is extremely gratifying to collaborate with one of our past students and her staff in such an effective programme, where knowledge and expertise has been disseminated to real effect through the training offered to Dr Khanal. We wish him every success as his project takes shape in Nepal, and thank him for the insights he has provided to us during his time at IoB and with the Costello team". Sumesh added; 'The internship has been a rewarding experience in many different ways. I've learnt many things from learning how to conduct a systematic review at Costello to learning about different aspects of running a bioscience business in the MBE course. I had the most valuable opportunity to work with many talented people from such diverse backgrounds but yet with singularity of purpose - the drive to learn.'*

CEB Academics 50th Anniversary of Landmark Book Publication



'Retired' Chemical Engineering academics Prof Davidson and Sir David

Fifty years ago in this department, young researchers John Davidson and David Harrison were carrying out pioneering works on fluidization, which were summarised in their book Fluidised Particles, published in 1963.

Prof John Davidson is now regarded as the founding father of the field of fluidisation in Chemical Engineering. He has been a member of this department since 1952 and was Head of Department from 1975 to 1993. He is a Fellow of Trinity College, he has been a Fellow of the Royal Society since 1974 and he continues to be an active member of the Department. In 2010 he was awarded the Prince Philip Medal by the Royal Academy of Engineering for sustained excellence in engineering.

Sir David Harrison has also had a long association with Cambridge. He completed a PhD in Physical Chemistry and then taught in this department until 1979. He left Cambridge but didn't leave education, becoming Vice-Chancellor of the University of Keele then Vice-Chancellor of Exeter University. In 1994 he returned to Cambridge as Master of Selwyn College, a post he held for 6 years, and in 1997 he was knighted.

He mentioned; "*It seemed the natural thing to do at the time, and in particular to gather up in one place a more analytical (rather than a descriptive) approach to the observed behaviour of fluidised beds. I think we somewhat surprised ourselves that we managed the work at a time we were both otherwise very busy - John as Steward of Trinity at a time of kitchen reconstruction and my taking up the reins as Admissions Tutor at Selwyn. Being busy when you are young is not necessarily a bad thing. The CUP deadline for the copy - August 1962 - had a special significance for me because it was the month in which I was married".*

John Davidson recollects; *"The book arose because David and I had, prior to writing the book, several productive PhD projects. It should be mentioned that the earliest work on fluidisation in the Department was from two Tripos research projects, the second being done by the late Robin Paul who subsequently had a highly successful industrial career. It was David's idea, about 1961, to write the book. I associate the actual work of writing with reconstruction of the Trinity College kitchen, 1961-3, a major project involving changes to a building dating back to 1605. As Steward I was responsible for detailed planning. So thoughts about bubbles were linked with food hoists, dishwashers, ventilation systems etc. When the proof finally emerged, the book seemed rather few pages after so much work. Typesetting was by hot metal; the diagrams were done by a draftsman, giving a rather better result than might nowadays be produced by a computer".*

Professor Jim Wilkes, another former lecturer here congratulated both of them adding; "*It's only 155 pages long, but it's beautifully written, concise, with lots of experimental evidence to back up the elegant theories. It is a fine summary of the pioneering work done on fluidisation in the Cambridge department".*

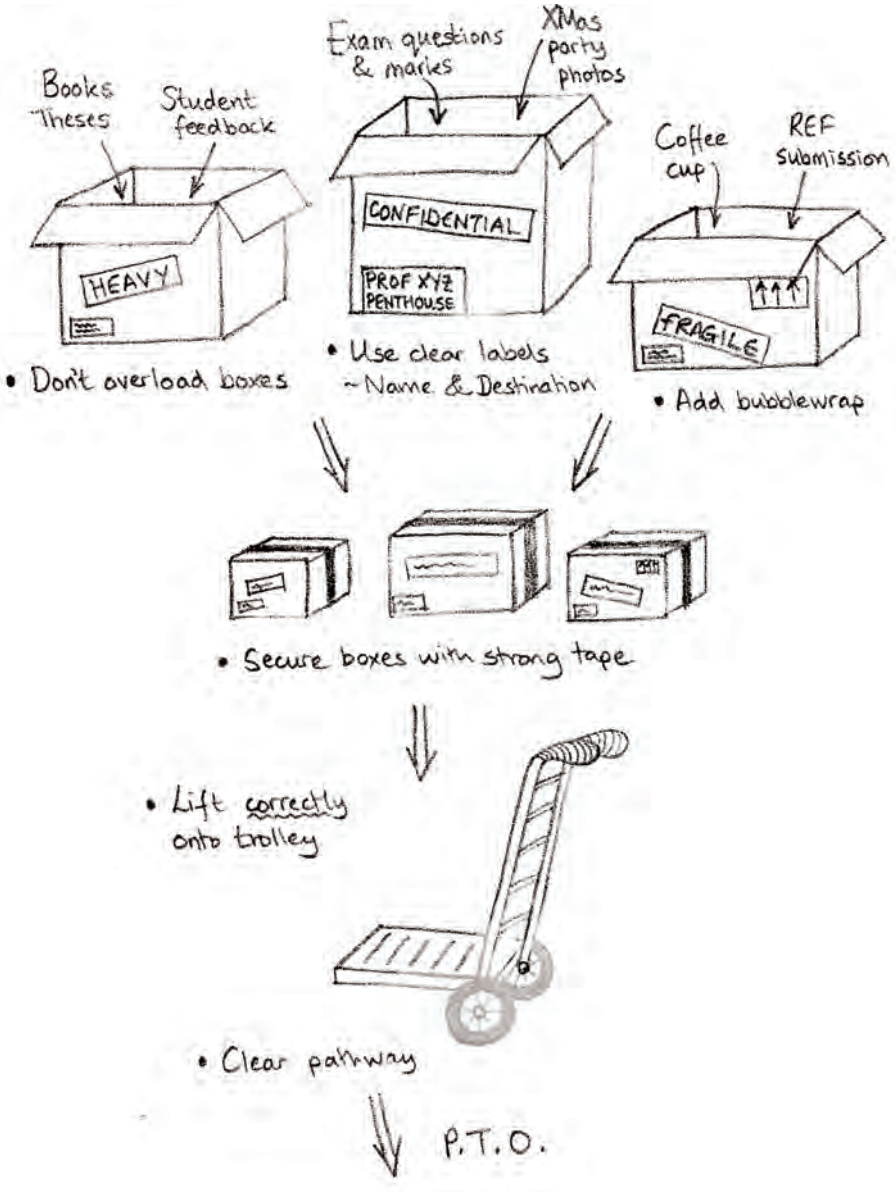
Dear Dr Sarah,

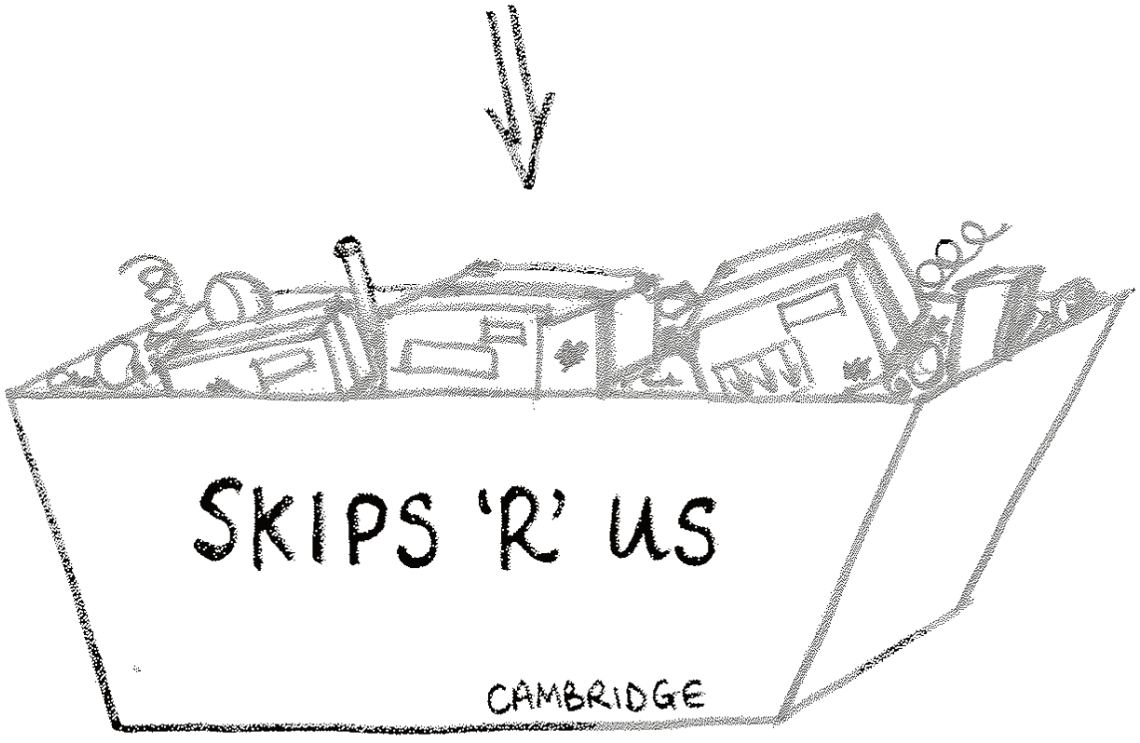
With the move to the new building drawing closer upon us, I am beginning to worry about the logistics if it all. I lie awake in Staff meetings fretting over how I should pack and relocate everything in my offices. Do you have any advice ?

Kind regards,
Professor XYZ

Dr Sarah says...

No doubt about it, moving Department is a stressful business. But the good news is I've already started thinking about it and have developed this helpful flow diagram to aid a typical office move. So no need to fret anymore, I promise!





JOB DONE ☺

Professor Lynn Gladden is the jewel in our crown

Professor Lynn Gladden,
Pro-Vice Chancellor for Research

I was at the Material Science Department in Cambridge the other day. Standing by the reception area at I started browsing through the magazine rack there when I came across an issue of the University's research magazine "Research Horizons". I started reading the intro on the first page signed by CEB's own Professor Lynn Gladden, former CEB HoD and Pro-Vice-Chancellor for Research. I was then instantly 'stung' by her statement: I found it so witty, sophisticated, precise and concise! Somehow, Professor Gladden had managed to condense the essence of scientific research into a few words, and mind you, after scanning through the other articles in the issue, I found these of a very good quality too! Now, I need to confess that I could not resist myself and committed a 'petty crime': I grabbed this issue of 'Research Horizons' and put it in my bag.

Now, I have a serious dilemma: I am wondering whether Professor Gladden, after she hears about my 'theft', will report the case at the next Board of Vice- Chancellors meeting and if so, will I then be prosecuted and punished in equal measures as a result of my actions?

If that is the case, so be it, but let us be clear on one thing: my passion for science breaks all boundaries, even surpasses legal boundaries. However, I have no regrets and, after enjoying my divine last supper like 'Cabestany's Itys'[1], I can sit back and reflect upon my 'shrewd misfeasance' for the rest of my days.

Cheers,

Zlatko Saracevic
CEB Senior Lab Technician and Amateur Poet
zss1001@cam.ac.uk

[1] Cultural reference to Itys, a character in Greek mythology legend, in 'The Cantos' by American poet Ezra Pound. 'The Cantos' is a long, incomplete poem in 120 sections, each of which is a canto. Most of it was written between 1915 and 1962.

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

CEB Teaching Consortium of Companies

For more information on the CEB Teaching Consortium visit www.ceb.cam.ac.uk/pages/teaching-consortium.html

UNIVERSITY OF CAMBRIDGE

Department of Chemical Engineering and Biotechnology

New Museums Site
Pembroke Street
Cambridge CB2 3RA

Tel: +44 (0)1223 334777
Fax: +44 (0)1223 334796

Institute of Biotechnology
Tennis Court Road
Cambridge CB2 1QT

Tel: +44 (0)1223 334160
Fax: +44 (0)1223 334162

Magnetic Resonance Research Centre
J J Thomson Avenue
Cambridge CB3 0HE

Tel: +44 (0)1223 334777
Fax: +44 (0)1223 334796

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

Design/production: www.cambridgedesigners.co.uk