

CEB *Focus*

Department of Chemical Engineering and Biotechnology



First CEB Industry Engagement Forum

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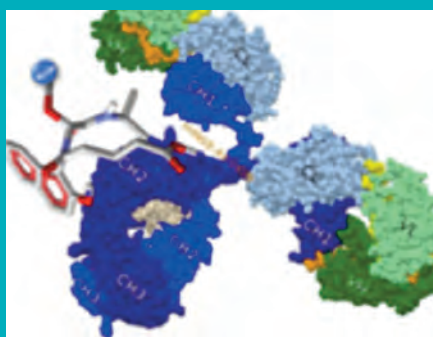
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Message from HoD Professor Nigel Slater



This quarter has seen the culmination of intense efforts to expand and strengthen CEB's international collaborations in its strategic research fields of Sustainability and Healthcare. Most prominently, the University of Cambridge and the National Research Foundation, Singapore, have

announced plans for a collaborative research centre, specialising in energy efficient, low-carbon chemical process technology, to be called the Centre for Carbon Reduction in Chemical Technology in Singapore. This is a substantial initiative that has been headed by

Professor Lynn Gladden together with Professor Markus Kraft and Drs John Dennis and Adrian Fisher. Further information is available at www.cam.ac.uk/research/news/cambridge-announces-centre-for-carbon-reduction-in-chemical-technology-in-singapore/. Simultaneously, the Department is advertising a new Professorship in Sustainable Reaction Engineering which has been made possible by the kind and generous support of Johnson Matthey plc. Together, these developments will place CEB firmly at the centre of international research in carbon reduction and sustainability. A strategically valuable cross-University initiative has also begun with the King Abdullah City of Science and Technology (KACST) of Saudi Arabia. As part of this initiative CEB will develop a novel but generic cryopreservation technology for the banking of human cells, an absolute prerequisite for their use as clinical products.

Notes from the Editorial Team

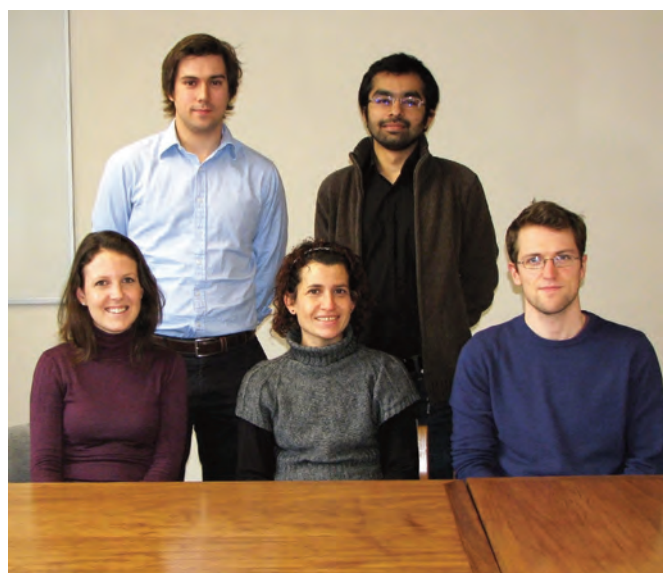
CEB Focus Editorial Team is led by Elena Gonzalez, PA to HoD, assisted by fellow editors Nick Ramskill, Marijke Fagan and Jawad Rehman. We would like to thank Alastair Clarke, who has recently left the team, for his invaluable contribution to previous issues and development of the newsletter. We are always keen to welcome new faces to our team, so please send an email to ceb-focus@ceb.cam.ac.uk if you are interested in joining us.

This issue's *Cover Article* focuses on the exciting plans for new building in West Cambridge which have recently been given the green light, very much facilitated by the help of corporate members like Johnson Matthey. *Research Highlights* features work by Alister Inglesby and Dr Graziella El Khoury while the *Research Feature* presents ground-breaking research in the field of fouling the process industries by Edward Ishiyama. Also worth noting is the *Alumni Corner* where alumnus John Potter gives his insights into *The Value of a Chemical Engineer's Education*. Finally, try your hand at our new *Teatime Teaser* department crossword!

CEB Focus would like to thank 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.

CEB Focus returns in October with a Michaelmas 2012 issue to welcome the new academic year 2012-13! The Editorial Team wishes you a wonderful summer!



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

First CEB Industry Engagement Forum

A Bridge from Academia to Commercial Success

Over a period of five terms, commercial companies will be invited to join CEB post-doc researchers and PhD students for a one-day session to explore how to align researcher interests with real commercial problems. The Industry Engagement Forum is to encourage early career researchers to think more broadly about potential societal and economic benefits arising from their research interests and to understand how they may increase collaborations with industry. This Forum is a wonderful, forward-looking initiative organized by Cambridge Enterprise and funded by the UK's Engineering and Physical Sciences Research Council (EPSRC). "Through programmes like this, Cambridge researchers are able to gain insight into current research topics of interest to MedImmune and other partner companies," said Dr Amanda Wooding of Cambridge Enterprise. "By all accounts, the first CEB session went extremely well, and we hope this programme can become an important resource, for both our academic and industrial partners."

CEB academics, early-career researchers and Medimmune industrialists got together with an aim to:

- Encourage early career researchers to understand how they may increase collaborations with industry
- For industry to gain access to research expertise in CEB
- Expose staff to current research topics of interest to Medimmune
- Identify areas of common interest that can lead to research collaborations, studentships or secondments



Victor Dillard, MBE student, presenting his ideas.

The first University of Cambridge Industry Engagement Forum took place on 14 March 2012. Over 25 post-doc researchers, PhD students and academic staff from CEB joined 11 scientists from MedImmune's Biopharmaceutical Development Cambridge team.



PhD students Christian Guyader and Matthew Townsend with Dr Graham Christie at the Hauser Forum.

Prof Nigel Slater, HoD, who took part in the activities, thanked all those who attended for their outstanding contribution at the Industrial Forum and added, "I am sure that our MedImmune colleagues were mightily impressed; they certainly enjoyed themselves and I am confident that we have provided a solid basis upon which a meaningful research collaboration can be built. But as important is the impression of us that they left with, and they can have had no doubt whatsoever that Cambridge can offer immensely professional researchers with vision and motivation - just what they need to build their business."

The aim was to brainstorm some of the key challenges facing the development of future biopharmaceutical drugs. During the session, participants discussed specific technical issues around biopharmaceutical manufacturing and how CEB's expertise could be utilized to provide solutions to these commercial challenges.

Dr Paul Varley (Vice President, Biopharmaceutical Development, MedImmune) said, "My team and I were delighted to be the first participants in this new

Industry Engagement Forum. It was a highly stimulating and energising meeting. The agenda, which we helped develop with CEB, involved brainstorming some of the key questions that challenge us in the commercialisation of new biological drugs, such as cost, reproducibility and administration route. It is also great to be working with such a leading group as the CEB on our door step here in Cambridge.”

MedImmune scientists then worked in individual teams with the CEB researchers to look at ways that academic research could help address these questions and develop new approaches and solutions. Each team then presented back its ideas and thinking to the Forum.

Dr Marcel Kuiper, a MedImmune Senior Scientist, who took a leading role in organizing MedImmune’s involvement in the Industry Engagement Forum, added, “This has been a great opportunity for MedImmune to forge strong on-going links with one of the world’s leading research organizations, and create greater understanding between industry and academia. In particular, we noted how the different mix of people created a real ‘buzz’ and enthusiasm throughout our discussions and team-working.”



The Best Project Competition winning team from left to right, Muhammad Safwan Akram, Dr Axel Zeitler, Krishnaa Mahbubani, Dr Graham Christie, Murtada Alsaif, MedImmune’s Paul Varley and Shahid Uddin with Prof Nigel Slater.

The level of debate and the flow and quality of ideas produced was quite impressive allowing CEB staff and researchers to appreciate the industry drivers for innovation, and the commercial challenges they face in doing so.



From left to right: Prof Nigel Slater and Richard Hunter from MedImmune with Dr Ken Seamon, MBE lecturer.

PhD student, Ipshita Mandal, who took part in the Forum said, “It was a brilliant initiative and the first of its kind that I have experienced. Not only does it raise the Department’s profile to corporate collaborators, but it also is an opportunity for researchers to learn from industry experts on cutting edge manufacturing and R&D being conducted in the company. An opportunity to be creative with brainstorming research ideas for innovation and collaboration, an opportunity to develop networks for future career interests, and in my opinion most importantly an opportunity to learn how to plan long term research collaborations between industry-academia.”

The team led by CEB academics Dr Axel Zeitler and Dr Graham Christie, and including a group of PhD students alongside MedImmune industrialist Shahid Uddin won the Best Project Competition with ‘stress buster antibody’. MedImmune being the first company to get involved in this initiative has already recognised the benefits and potential of this collaboration. CEB now hopes other corporate partners will follow suit and team up with them for future.

CUCES Annual Dinner 2012

Akshay Deshmukh, CUCES President 2011-12

On the evening of the 2nd March, students, staff, alumni and friends of the department came together to enjoy the 2012 CUCES Annual Dinner at the Double Tree Hilton hotel. The evening began with a sparkling wine reception and moved onto the Granta Suite of the hotel for a three course dinner and plenty of wine. During the dinner, guests were treated to a mathematically involved speech from the current Head of Department, Professor Nigel Slater and subsequently with a DJ taking forward the entertainment baton late into the night. Students, staff and guests then advanced upon several of Cambridge's most reputable nightlife establishments, enjoying the evening well into the early hours.

Following in a tradition older than the current committee, the Annual Dinner proved to be a great success. The CUCES committee would like to thank all of the attendees for brightening the evening with their inner radiance. We are indeed fortunate to serve such an enthusiastic and sociable undergraduate body. A special mention must go to Dr Kam Yunus for once again dancing until 3am and Dr James McGregor for his fine blade, and then bandage, display.

The CUCES committee would like to take this opportunity to thank the Department, Professor Nigel Slater and Dr Bart Hallmark in particular, for arranging the sponsorship of the dinner after the late withdrawal of a sponsor.



CUCES Annual Dinner at Doubletree Hilton

Note from Outgoing CUCES President

Akshay Deshmukh, CUCES President 2011-12



Akshay (far right) with CUCES Committee

The raison d'être of CUCES, and indeed the CUCES committee, is to facilitate the interaction between students and a range of chemical engineering related industries, in addition to providing and maintaining the inclusive social atmosphere which distinguishes our department. As a committee it has been a pleasure to serve these purposes and our fellow students throughout the Department.

Last year I was fortunate to inherit the CUCES presidency from a CUCES committee which had come in the top five student committees across the country in the National Placement & Internship Awards 2011. I would like to think that as a committee we have maintained these standards in the face of a new range of challenges and opportunities. I would first and foremost like to thank my committee, Marina (secretary), Laurence (treasurer), James (careers rep), Erica (events coordinator), Ben (social sec), Zsige (IT & publicity) and Lauren (part 1 rep) for their hard work and commitment throughout the year. I would also like to thank the department, in particular Dr Bart Hallmark, for helping us organise the vast range of careers events in Michaelmas term.

Going forward CUCES will face a changing set of challenges as well as a wave of new openings and prospects and I wish Lauren Atherton, the incoming CUCES president, and her committee the best of luck in the coming year. I am indeed privileged to have had the opportunity to serve on two CUCES committees and I would like to thank Constantinos' and my committees for making my time in the chemical engineering department so enjoyable – I will indeed miss being part of the CUCES committee!

Psynova at SchizDX Symposium

*Dr Paul Guest (CEB post-doctoral Researcher)
and Dr Paul Rodger (Psynova Neurotech Ltd. Director)*



On March 22nd 2012, members of the SchizDX consortium held a public symposium at the Pitt Building to mark the end of a successful collaborative research project, which was funded by the EC through its FP7 Framework. The aim was to identify molecular biomarkers for use as a blood test to aid early diagnosis of schizophrenia. The consortium was comprised of scientists and clinicians from Germany, the USA, Estonia and Ireland, alongside the Bahn Lab at the Department of Chemical Engineering and Biotechnology, and Psynova Neurotech, a spinout company from the Bahn Lab.

The current diagnosis of schizophrenia is subjective and takes six months to three years for confirmation. This can result in years of untreated psychosis during which disease severity can increase, leading to a worse outcome. The use of a blood test would revolutionise the clinical management of affected individuals since earlier treatment is associated with improved outcome.

The project successfully met the challenging objectives by discovery of a validated biomarker panel for schizophrenia. This, in turn, has resulted in the launch of the first blood test for diagnosis of schizophrenia (VeriPsych™) by Psynova and Myriad-RBM in the USA. The test is expected to result in a quicker and more cost effective diagnosis for some patients. More details of the project on www.schizdx.eu

Salone Satellite Showcase

CEB's Electrochemistry Research group led by Dr Adrian Fisher, showcased their BPV (Bio-Photo-Voltaic) Moss-Table Project at the recent Salone Satellite Exhibition in Milan (Italy). This project is a joint collaboration between CEB and the Departments of Biochemistry, Plant Sciences and IfM.

The SaloneSatellite was created in 1998 to bring together the most promising young designers from all over the world with the most important business people and talent scouts gathered in Milan to visit or exhibit at the Saloni. Each year 700 young designers and students of the most prestigious design schools and universities exhibit and exchange ideas at this unique showcase. The proposals are evaluated by international professionals from the world of design, architecture and media.

CEB Electrochemistry researcher Paolo Bombelli who presented the Moss-Table commented, "The event was very successful and exceeded our expectations. Our project perfectly fitted the Salone Satellite theme of 'Design and Technology'. Out of 10,600 people who engaged with our stand during the six day event, 820 expressed an interest in making contact after the show". It has also been exhibited at the London Design Festival, Cambridge Design Icons and Everything Forever Now.



More info on this event can be found on www.cosmit.it/it/milano/i_saloni/salonesatellite

Scientific publications based on the BPV core technology

P. Bombelli, R. Bradley, A. Scott, A. J. Philips, A.J. McCormick, X. Anderson, K. Yunus, D. S. Bendall, P. Cameron, A. G. Smith, C. J. Howe, A. C. Fisher, *Energy Environ. Sci.*, 2011, 4, 4690-4698.

A. J. McCormick, P. Bombelli, A. Scott, A.C. Fisher, C.J. Howe, *Energy Environ. Sci.*, 2011, 4, 4699-4709.

R. J. Thorne, H. Hu, K. Schneider, P. Bombelli, A. Fisher, L. M. Peter, A. Dent, P. J. Cameron, *J. Mater. Chem.*, 2011, 21, 18055-18060.

Sustainability Matters

Dr James McGregor
Department Lecturer

The term *sustainability* is increasingly used by the media, scientists, environmental organisations, politicians and others; tens of thousands of news articles including this phrase are indexed on Google each day. In many of these cases however, *sustainability* is used as a qualitative, catch-all term describing various facets of environmental, economic and societal policy. Chemical engineering is by its nature a numerate, quantitative discipline. Chemical engineers are therefore well placed to provide a rigorous assessment of whether a product, process or service is indeed *sustainable*. In this context sustainability necessitates reducing energy demand and the emission of carbon dioxide, without harming the environment. At its core is the concept of resource minimisation. This extends not simply to conventional process engineering and large scale chemical plants, but to a consideration of e.g. solar energy, biofuels and water availability. The latter plays a key role in agricultural development which in turn may have a significant societal impact. For instance, water shortages leading to increased food prices were directly implicated in the unrest in North Africa and the Arabian Peninsula last year, while closer to home water shortages have led to Cambridgeshire recently being declared a drought zone.

The Part IIB lecture course *Sustainability in Chemical Engineering* aims to provide students with the means to quantify the concepts described above through introducing two key tools: Life Cycle Analysis (LCA) and exergy analysis. LCA is an approach to assessing the complete environmental impact of a product or service and is often described as a cradle-to-grave assessment including, as it does, resource utilisation during manufacture, use and disposal. Exergy is a thermodynamic quantity that encapsulates both the energy and the entropy flow through a system. Reducing exergy consumption is tantamount to reducing resource consumption. For both LCA and exergy analysis the course presents a number of case studies. When applied to chemical processes such analyses allow, for example, the least efficient (or sustainable) steps to be identified. They therefore provide a direct indication of where changes should be



made in order to make these processes more sustainable. Examples discussed range from desalination plants to home-baked bread. Recent student comments upon completion of the course have included, “I think it's really important that all graduating chemical engineers have some concept of how important these issues are and how much they are linked with the chemical engineering industry. It was very interesting to learn about so many different issues in an academic way”; and also, “We constantly hear the word *sustainability* but didn't really understand the true meaning until now. I think we're now far more equipped to go out into the world and speak about or analyse different processes intelligently.” Hopefully these are sentiments shared by all of those in the class.

Of course, sustainability is also an important research area within CEB and the undergraduate course is a reflection of this focus. CO₂ capture and subsequent conversion and the development of more selective catalytic processes are just two examples of departmental research in this area. At the other end of the spectrum, research is also on-going to understand the technology behind proposed geoengineering solutions to offset the effects of climate change should current efforts to reduce carbon emissions be insufficient. Such studies are a reflection of the urgent challenges that are presented by society, and the position of chemical engineers to address these challenges. It is in this context that the course aims to equip students with the necessary tools in order to develop a quantitative understanding of such issues and the skills to tackle these and other problems in the future.

Downstream Processing of Biopharmaceuticals

Dr Graziella El Khoury, Healthcare Biotechnology

Our group is involved in the development of a variety of novel affinity ligands for the purification of high value recombinant therapeutic proteins.

The global market for biopharmaceuticals is projected to reach US\$182.5 billion by 2015. These products comprise monoclonal antibodies (mAbs), vaccines, erythropoietin, insulin, cytokines, hormones and other biomolecules. For example, mAbs constitute one of the most rapidly growing categories of biopharmaceutical, with more than 25 antibodies approved by the FDA and 240 currently in clinical trials. However, issues, such as healthcare reform and the increased demands upon healthcare budgets are forcing the pharmaceutical industries to reduce the manufacturing costs. Moreover, due to the development of new approaches for the upstream processing and the increase in protein production yields from mammalian cells (5g/L), the production bottleneck for some high volume products is shifting towards the downstream processing, which may constitute up to 80% of total manufacturing costs.

The concept of the “well-characterised biologic” requires that the biological molecule has to be characterised for its identity, purity, impurity profile and potency. Regulatory reform is likely to stimulate the development of new high-resolution separation processes. Of particular concern is the resolution and purification of variants of the target itself, resulting from differences in glycosylation, folding, sequence, oxidation and a multitude of other post-translational modifications. The ability to resolve multiple glycoforms of therapeutic proteins, for example, is crucial since the product registration is based on a particular isoform composition.

Among the different classes of biopharmaceuticals, our research is focused on the development of synthetic affinity ligands for immunoglobulins (IgG and its fragments) and other glycoproteins, (erythropoietin).

The aim is to implement cost-effective and highly efficient purification protocols, in order to reduce the purification and polishing steps during the downstream processing, and replace the biomolecules currently used in affinity chromatography. Biological affinity ligands,

such as IgG-binding proteins (Proteins A, G and L) and sugar-binding proteins (lectins), suffer from a wide range of limitations: They are expensive to produce and purify, may be contaminated with host DNA and viruses, show lot-to-lot variation, and low scale-up potential, and they may be degraded during conventional sterilization-in-place (SIP) and cleaning-in-place (CIP) procedures and lead to ligand leaching and subsequent contamination of the end product with potential toxins.

The synthetic affinity adsorbents are based on “biomimetic” ligands and the notion of *de novo* ligand design and intelligent combinatorial libraries. The ligand synthesis follows a defined five-part strategy which comprises: (i) Identification of a target site and design of a complementary ligand based on X-ray crystallographic studies of complexes between the natural target protein and the biological ligand; (ii) solid-phase synthesis and evaluation of an intentionally biased combinatorial library of related ligands; (iii) screening of the ligand library for binding the target protein by affinity chromatography; (iv) selection and characterisation of the lead ligand,

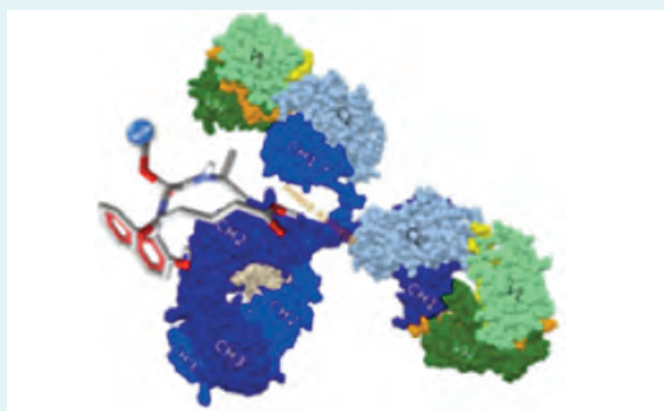


Figure 1. IgG molecule binding to an Ugi ligand immobilized on Sepharose beads (blue sphere)

supported by *in silico* molecular modelling and docking of the ligand into the target protein, and (v) optimisation of the adsorbent and chromatographic parameters for the purification of the target protein. We are currently applying a new approach for the solid-phase synthesis of the ligands. It is based on the

multicomponent Ugi reaction, which is a four-component reaction in which an oxo-component (aldehyde-activated agarose beads), a primary or secondary amine, a carboxylic acid and an isonitrile group are condensed, in a one-pot reaction conducted at a constant temperature (50°C), to yield a di-amide scaffold product. The Ugi components can be varied to mimic key amino-acid residues of the biological ligand which are involved in its interaction with the target molecule. This approach also introduces the possibility of developing branched, cyclised and 3D affinity ligands.

We have developed various Ugi ligands mimicking different IgG-binding proteins, namely, protein L and protein G. The protein L mimic was developed for the isolation of IgG from crude extracts, and more specifically for its ability to bind IgG-Fab fragment.

Moreover, we have recently synthesised and characterised a protein G mimic for the purification of mammalian immunoglobulins derived from different species and particularly the non-conventional camelid IgGs.

Camelid IgGs, present in the serum and milk of *Camelus dromedaries*, contain Ig subclasses that naturally lack light chains; they are termed “heavy-chain” antibodies or HCAb and display a molecular weight of ~95kDa instead of 160kDa for conventional mammalian antibodies. Their heavy chain also lacks the CH1 domain and the heavy chain only variable domain (VHH) is connected directly to the constant domain (CH2 and CH3) via the hinge region. The small size of these VHH domains (~15kDa) allow greater access to buried epitopes and recognition of antigenic sites in clefts that generally could not be reached by larger conventional antibodies and hence they are effective enzyme inhibitors.

Furthermore, we are currently focusing on the development of a variety of branched and complex Ugi ligands for different immunotherapeutic proteins and glycoproteins of interest. The relative ease of conducting the Ugi reaction suggests that this work may become the gold standard procedure in use worldwide for selective processing of high value biopharmaceuticals.

Microbial fuel cell research in CREST

Alister Inglesby PhD Student, CREST

Microbial fuel cells (MFCs) are bioelectrochemical systems (BES) that use bacteria and their associated biocatalytic reactions for electric power generation. MFC technology has received much attention within the bioenergy field due to its potential for powering diverse technologies from wastewater treatment to autonomous sensors for long-term operations in low accessibility regions.

Work conducted on MFC technology by the Center of Research in Electrochemical Science and Technology (CREST) under the guidance of Dr Adrian Fisher has focused on the development of micro scale MFC devices, which support parallel, low cost and reproducible systems for high-throughput screening and sensitivity analyses of biological and electrochemical performance parameters respectively. Further application of MFCs as secondary modules in anaerobic digestion (AD) systems has been investigated. MFCs offer a number of complementary properties to AD systems such as toxic ion mitigation, pH buffering and improved bacterial retention.

International collaborations have developed from this project with the work recently being presented in Thailand and Singapore at the UK-Southeast Asia Partners in Science on New Approaches to Emerging Energy Systems workshop. The seminar was co-organised by Electrochemical Materials and System Laboratory, National Metal and Materials Technology Center (MTEC), Royal Society of Chemistry, UK, and British High Commission in Singapore. The primary objective of the seminar was to provide an opportunity for Thai and Singaporean researchers to meet leading UK researchers in the area of fuel cells (including microbial fuel cells) from academia.

CREST have recently had the following journal articles accepted with the former being recommended as an RSC ‘Hot Article’.

References

- Inglesby, A. E., Beatty, D. A., Fisher, A. C., 2012, *Rhodospseudomonas palustris* purple bacteria fed *Arthrospira maxima* cyanobacteria: demonstration of application in microbial fuel cells. R.S.C. Advances, DOI: 10.1039/C2RA20264F, Accepted Manuscript
- Inglesby, A. E., Beatty, D. A., Fisher, A. C., 2012, Enhanced methane yields from anaerobic digestion of *Arthrospira maxima* biomass in an advanced flow-through digester with an integrated recirculation loop microbial fuel cell, Submitted to Energy and Environmental Science

The Fouling Trap: Trap of our own Making

Dr Edward Ishiyama, Powder and Paste Processing Group

Process industries have lived with fouling ever since the beginning. Fouling is the formation of unwanted deposits on surfaces. Types and mechanisms of fouling are versatile; white scale formed in water kettles are a familiar example. Fouling deposits have a relatively low thermal conductivity hence their formation on heat transfer surfaces reduces their thermal efficiency. When fouling occurs in process flow streams there is a tendency to cause hydraulic limitations; imagine the formation of cholesterol in our heart arteries. In this article, three examples are illustrated to emphasise the importance of coupling thermal and hydraulic effects in fouling analysis, which would otherwise result in severe traps.

Trap during design – Use of fouling factor

Take an example of a heat exchanger design exercise. One common approach to face fouling in heat exchangers is the use of ‘fouling factor’. Fouling factor

the use of ‘fouling factor’ results in more surface area for fouling and sometimes a lower flow velocity. In certain processes (such as crude oil refinery), the tendency of fouling increases with lower flow velocity (i.e. lower surface shear) and higher surface temperature. Hence in the long run, the oversized unit could result in higher fouling penalties than the original design (despite the increase in capital cost); thus trapping the designers with the misuse of fouling factors (Figure 1).

Trap during operation – Thermo-hydraulic channelling

A hydraulic aspect related to flow resistance was identified by observation of the parallel hundred foot drains of the Cambridgeshire Fenlands. Consider a stream which initially splits into equal flows Figure 2(i). Assume that there are few weeds growing on the stream path ‘b’ giving a higher flow resistance compared to stream path ‘a’. The flow split will spontaneously adjust



Design 1
Fouls



Design 2
Fouling factor from
‘design 1’ used in ‘design 2’,
but actual fouling is worse!



Design 3
Increased fouling factor from
‘design 2’ used in ‘design 3’.
Actual fouling is even worse!!!

Figure 1. Use of fouling factor in heat exchanger design (Figure taken from Pugh et al., 2011)

in design, results in oversized units and unit oversize is based on the analysis of heat exchanger performance using effectiveness – NTU method; i.e. for bigger exchangers the drop in effectiveness due to fouling is less. This analysis masks the hydraulic performance and it is important to bear in mind that

to take the path that has less flow resistance causing flow degeneracy, Figure 2(ii). Less flow in path ‘b’ would mean a favourable environment for the weeds to grow, hence more weeds (i.e. more flow resistance). If this continues, as in Figure 2(iii), path ‘b’ would completely disappear.

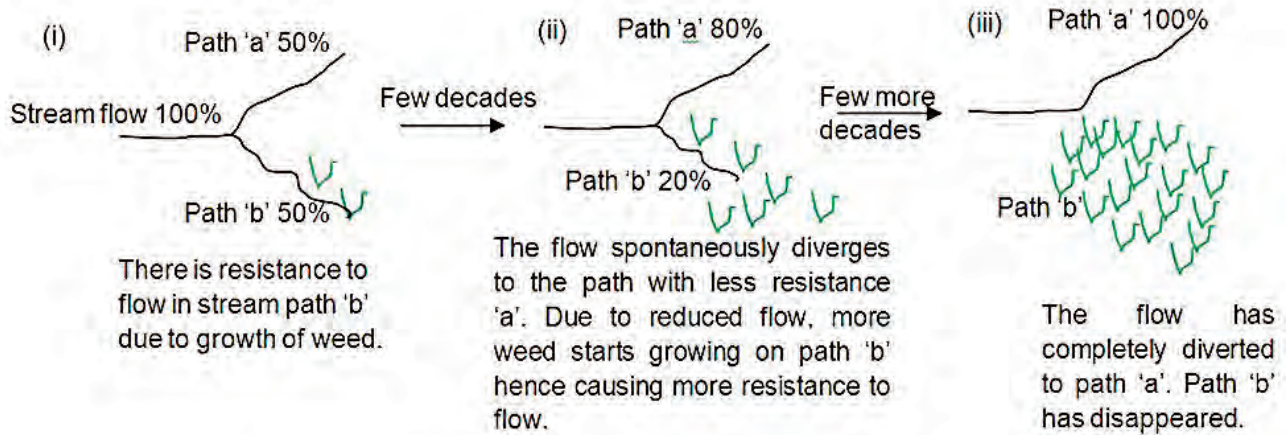


Figure 2. Flow channelling in Cambridgeshire fenlands

Similar flow degeneracy could occur in certain heat exchanger arrangements. Consider a schematic representation of a highly simplified installation of two exchangers in parallel, with the exchangers being notionally identical (only *A* is slightly fouled than *B*, and *B* is completely clean), (Figure 3). C_1 , C_2 represent cold stream flows and H_1 and H_2 represent hot stream flows.

Assume the case where the crude oil is heated through

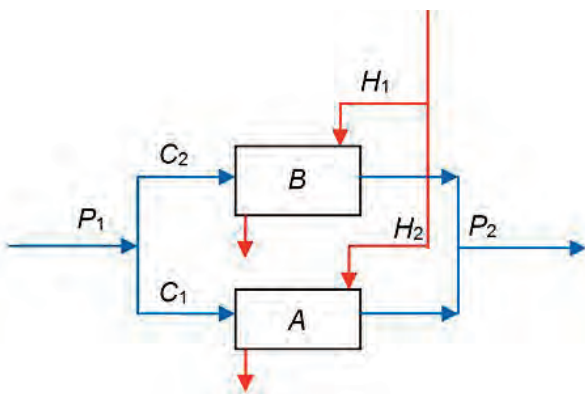


Figure 3. Thermo-hydraulic channelling in heat exchangers arranged in parallel

these units and that the rate of fouling increases with reduced flow velocity and increased surface temperature. The crude stream split is not controlled, so flows C_1 and C_2 will differ, with $C_2 > C_1$ (as *A* has a slightly higher flow resistance than *B* due to the initial fouling): the hot streams H_1 and H_2 are assumed to remain equal. The imbalance will result in *A* experiencing a higher film temperature and lower wall shear stress, i.e. a higher fouling rate. The available pressure drop, $P_1 - P_2$, is common to both *A* and *B* and therefore the cold stream flow in *A* will continue to

decrease. The net result is that fouling in *A* will reinforce the flow imbalance, increase fouling rates and give rise to a greater disparity in behaviour. This positive feedback phenomenon is termed 'thermo-hydraulic channelling (THC)'. THC phenomenon masks the actual extent of fouling and has a considerable adverse impact on the overall network performance (Ishiyama *et al.*, 2008).

Trap during monitoring exchanger performance

One important aspect of fouling is that the thermo-physical properties of the foulant deposit could change with time (e.g. when exposed to a heated surface for a prolonged period such as pizza source on the heating tray; they would become much harder to clean). This phenomenon is known as deposit ageing. Ageing of deposits strongly effects how we interpret unit performances. Usually heat exchanger performances are monitored using fouling resistances. Fouling resistance, R_f could be denoted by

$$R_f = \frac{1}{U} - \frac{1}{U_{cl}}$$

Here U and U_{cl} are the overall heat transfer coefficient at operating and clean states, respectively. For simplicity, assume that the relationship between fouling resistance and the deposit thickness, δ , could be given by a thin-slab approximation,

$$\delta = R_f \lambda$$

where λ is the deposit thermal conductivity.

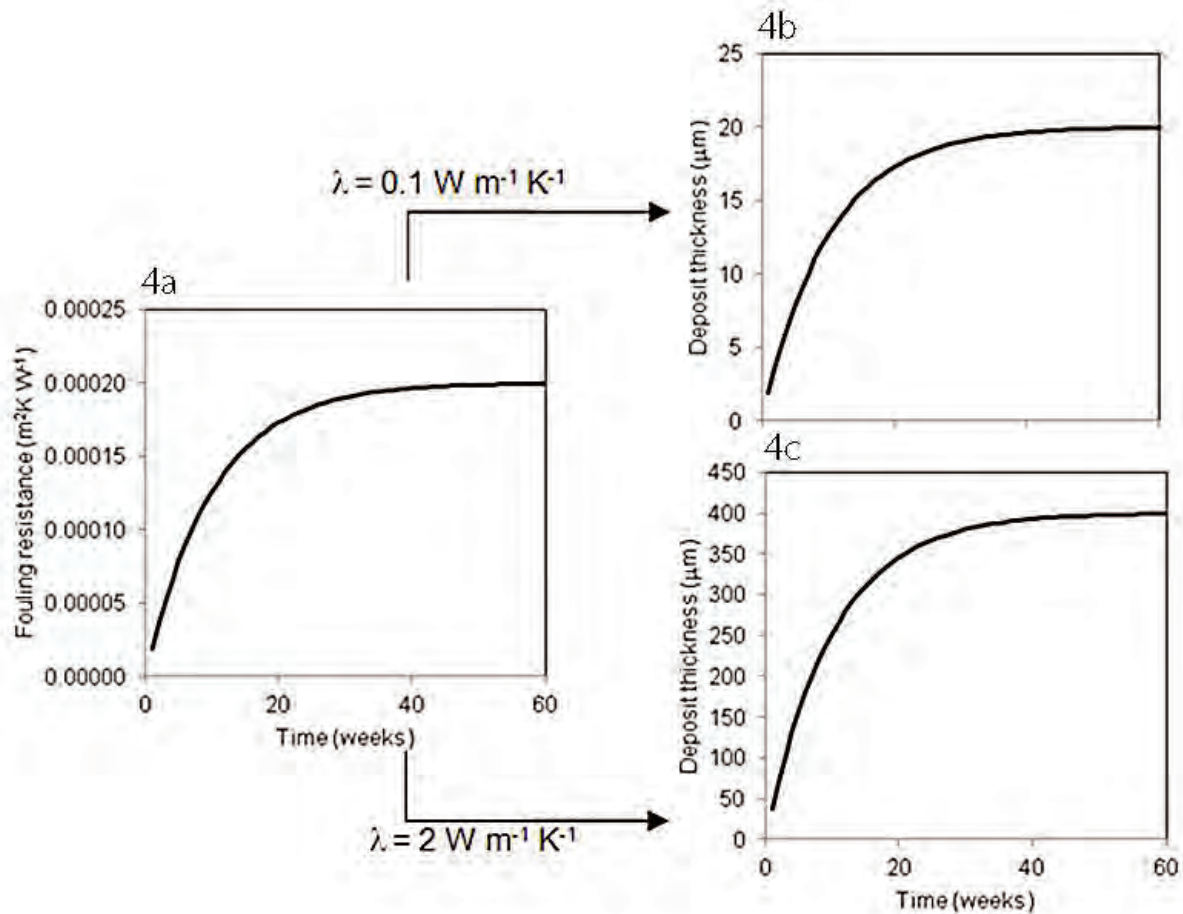


Figure 4: Estimation of deposit thickness based on fouling resistance under different deposit thermal conductivities using 'thin-slab' approximation

Consider a fouling resistance profile given in Figure 4(a). The fouling resistance profile is usually obtained through temperature and flow measurements. The hydraulic effect of fouling is masked in the absence of pressure drop measurements as with ageing, the thermal conductivity of the material is no longer the value of a non-aged deposit, and interpretation of the extent of fouling could be misleading as in the two extreme cases as shown in Figure 4(b) and 4(c). Figure 4(b) represents an example of the deposit thickness when all deposit is non-aged and representing a thermal conductivity of $0.1 \text{ W m}^{-1} \text{ K}^{-1}$. Figure 4(c) shows a case when all deposits are fully aged with a thermal conductivity of $2 \text{ W m}^{-1} \text{ K}^{-1}$. The message is to be aware of the importance of considering deposit ageing in engineering applications, so that the thermal performance could be correctly interpreted when deducting hydraulic performance.

Conclusions

Fouling plays a key role in interacting between the thermal and hydraulic performance of heat exchangers. Three fouling related issues were highlighted that could trap engineers during design, operation and monitoring of heat exchangers.

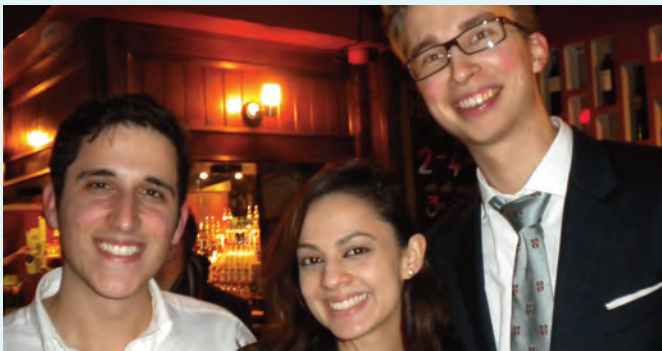
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- Pugh S.J., Ishiyama E.M, Polley G.T., Kennedy J., Viellet M., Paterson W.R. and Wilson D.I. (2011). Next generation software for management of crude refinery preheat trains subject to fouling, *Heat Transfer Society Forum*, Westminster, London

Meet the Oxbridge Biotech Roundtable (OBR) Cambridge Chapter

OBR is a network of students, academics and professionals from science, business, law and other fields connecting idea-holders across the UK and US with one another and with industry resources. Their aim is to bring down barriers between people interested in the life sciences industry in order to help move ideas forward.

This community transcends the online space and offers numerous opportunities to collaborate and learn through our online publications, business development workshops, industry immersion program and talks at affiliated institutions from leaders from biotech, pharma, finance, law and entrepreneurship.



OBR Cambridge from left to right Dan Perez, Lalarukh Haris and Gabriel Mecklenburg

CEB Focus caught up with Lalarukh Haris, the OBR Cambridge President and Director of Education & Development, at Addenbrookes Hospital where she is based as a PhD Candidate in the Department of Medicine.

How did OBR actually come about?

My colleague, Dan Perez founded OBR in 2011. He was always interested in how science gets brought to the real world, and was disappointed there wasn't more of a conversation on campus between academics (these people who think for a living), and professionals with the commercial experience necessary to act on an idea. It seemed odd to him that after a company would spin-out, most of the conversation with other on campus thinkers would end. So he started OBR firstly as a way to "start a conversation". After a brief summer pilot at Oxford attracted several hundred members, he

decided a similar vacuum and value proposition existed in Cambridge – and the team appreciated that only good could come from increased dialogue between Oxford/Cambridge. That set us on an interesting model of connecting various innovators from diverse campuses & disciplines not only with each other but with industry resources.

How do you operate and how do you manage to put on such an impressive event programme?

OBR is now spread out in 4 main chapters, each of which has its own committee. These committees are then run by a main executive committee that has eight members. We also have a central Education and Development Committee that decides on the themes and speakers of events for each term. OBR Cambridge is operated by the hard work of sixteen individuals, each of which has an assigned role. We have five team leads at Cambridge which delegate and work on roles such as business development and event management months before the event actually takes place.

What is your specific role within the Executive Committee?

Within the Executive Committee, I am the Director of Education and Development as well as President for OBR Cambridge. It is my duty to present event themes and speakers to the committee as well as ensuring the OBR Cambridge chapter runs efficiently.

We are delighted to hear that our own Prof Chris Lowe is a member of your Scientific Advisory Board. How has his contribution helped the running of OBR?

Prof Chris Lowe has been a great advisor for OBR Cambridge. He has been open to my suggestions and given me direction in steering the Cambridge Committee. He has supported us throughout our reload this year.

Where do the much-needed financial resources to operate come from?

Our financial resources are pooled from various sources of sponsorship and partnership. These are companies and organisations that believe in our aims and share the

same passion towards Biotechnology. Some of our biggest sponsors are: Stevenage Bioscience Catalyst, Venner Shipley, Oxford Biotherapeutics and Imperial Innovations.

What is OBR's mission and the main objective behind your work?

We are a group of students, academics and professionals who believe in breaking down the barriers between the scientific and industrial community. We want to bridge the gap between these two and foster a communicative and novel platform that will move innovative ideas forward. I personally did my undergraduate degree in Biotechnology before I moved towards Medicine. However being in the medical sciences has made me aware of the disconnection between the world of industry and the discoveries in medicine. I believe commercialisation and connection of ideas is something that needs to be highlighted in the UK, OBR is one such platform that allows this to happen through education, communication and consulting.

Could you tell us about the OBR network of volunteers helping you organise events?

OBR Cambridge has partnered up with Cambridge University Technology and Enterprise Club (CUTEC), Cambridge University Entrepreneurs (CUE) and Judge Business School on many of our past events. We have a great relationship with these organisations and amongst others we help out by means of reciprocal volunteering on the day of an event and advertising prior to our events. We aim to spread out our network through Cambridge Science Park and institutes such as Babraham, Sanger and European Institute of Bioinformatics (EBI). Our network involves a diverse range of professions from medics, scientists, engineers to business men, lawyers and computer scientists.

Amongst these professional we cater to an audience of undergraduates, graduates, post docs, academics and industrialists.

Our events this term are targeting two main themes: Management & Leadership and Mergers & Acquisitions. These themes will be targeting a segmented sub-theme in each campus, keeping consistent with the main theme in the next term. Incidentally, Prof Chris Lowe contributed a talk to Management & Leadership back in April.

How could CEB help OBR achieve its goals?

OBR is a greatly successful and young platform that that brings various disciplines together in passion of moving biotechnology forward. CEB is an existing department that achieves and shares the same passion as us. By connecting these two at Cambridge we can help each other cultivate and promote this idea.

Finally, how could our students get involved and what is to be expected?

We are fast moving organisation, which means we are always coming up with new projects and new positions within our team. If you are passionate and driven and are looking for a platform to become an entrepreneur or connect ideas with life sciences and the biotech industry, please get in touch with us.

Our events are a great source of what we are, so attending our events and networking with our professionals is something that offers great value to anyone interested in what we do.

For OBR Cambridge vacancies go to www.oxbridgebiotech.com or contact Lala on lalarukh@oxbridgebiotech.com



At the launch of the OBR Cambridge chapter

Organic Drive

Tom James



From 2004 to 2008 I studied for a MEng in the Chemical Engineering Department (as it was then). I had the opportunity to undertake both research, such as using superparamagnetic nanoparticles to target tumours with the CUBE team, and design: the brief to our year's design project was for a bio-butanol plant, which would turn out to be taste of my future choice of industry.

Towards the end of my time in Cambridge, like many engineers, I started looking into the management and strategic consulting industries. After graduation I spent two years working with an operations consultancy across several industries: from BAE Submarine Solutions on the Astute Class in Barrow-in-Furness, and the Vanguard Class refit in Devonport, to healthcare in the NHS. The time I spent in consultancy gave me exposure to various organisations, and gave me an understanding of how successful businesses work.

After a couple of years I became increasingly disillusioned with my place working in the consulting industry. I realised that, if I were not careful, I could easily fall into the trap that has befallen so many other young individuals working in the sector, every year becoming more dissatisfied with what they were doing, yet increasingly less able to do anything about it due to the inevitabilities of a mortgage, a family, and the baggage that comes with a regular white collar career. At the end of 2010 I left consultancy with two colleagues, Duncan Morrison and Geoff Cunningham, to form the biofuels company Organic Drive. By the summer of 2011 Organic Drive had designed and commissioned its first plant.

Biodiesel market

Although there are several organisations in the UK who use biodiesel in rich blends with mineral diesel as part of their Corporate Social Responsibility, most biodiesel is blended up to a 7% limit by the fuel majors and sold at forecourts as EN 590 diesel. Biodiesel is also used by

green-conscious organisations as a drop-in replacement for heating oil and in CHP.

Process

The basic reaction at the heart of the biodiesel production process is the transesterification of triglycerides (vegetable oils and animal fats) with excess methanol using acid or base catalyst to produce glycerol and the fuel, consisting of fatty acid methyl esters (FAME). At the end of the reaction the glycerol and FAME are separated. The FAME must then be cleaned before it can be sold, meeting the European Standard EN 14214.

A plant with capacity of 5,000 tonnes p.a. would normally cost in the region of £5M. However, a budget of less than £200k would require serious improvisation and innovation. My background in chemical engineering would help the design and build of a novel plant within 6 months without any commissioned expertise. CapEx and Opex were massively reduced, vitally important because the business was self-funded by the three business partners.

Main reactor

Oil and methanol exist in two phases. High shear is needed in order to mix the two phases and enable mass transfer for the reaction to take place. To avoid the cost of a specifically commissioned reactor and high shear impeller, an ex-fermentation vessel was adapted for the task and fitted with a baffled recycle loop to provide the high shear necessary.

Crude biodiesel purification

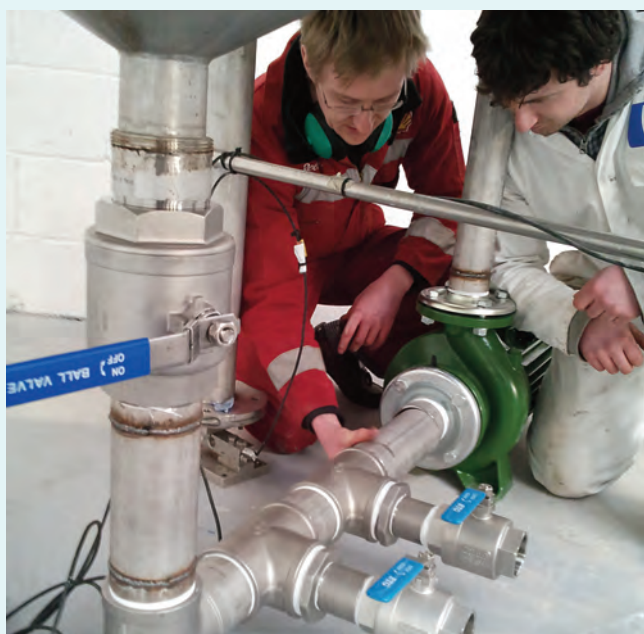
Once the excess methanol has been recovered from the crude biodiesel the product must be purified to remove excess catalyst, soap by-product, and trace glycerol, along with other contaminants. The traditional method for achieving this involves counter current water washing. This has several drawbacks: product is lost in the waste water; the washed biodiesel must go through further refining; the waste water can present an environmental hazard; water adds cost to the process. These problems were avoided by using a novel two stage adsorption/ion exchange process:

- Cellulosic stage – the biodiesel is passed through a cellulosic adsorbent material made from waste

sawdust from saw mills. This material is free and produces an excellent renewable solid fuel once breakthrough has occurred.

- Ion exchange/styrene-divinylbenzene copolymer adsorption stage – this step is adapted from a unit operation traditionally used in pharmaceutical purification and has been studied in the labs of CEB. The previous inexpensive cellulosic adsorption step means that the life of the ion exchange media is greatly prolonged.

Organic Drive is the first company in the world to be able to meet EN 14214 at a commercial scale with this novel process, and in recognition of this in November of 2011 I was runner-up in the IChemE's Young Chemical Engineer of the Year Award.



Duncan Morrison and Tom James lining up pipework

Many of you reading this will be thinking about what your next steps will be in your career. You may be thinking about staying in academia, looking into becoming a professional engineer, or exploring the possibilities outside of chemical engineering, as I originally did. What I would say to you now is that there are limitless opportunities out there, and the skills that one learns as a chemical engineer can give you a disproportionate advantage in areas that have a massive technical barrier to entry. Get out there and make stuff.

Alumni Speaker Series

Thursday 24 May 2012, 4.00pm

Alumna **Dr Wendy Alderton** (Director of Science, Abcodia) will be giving the last presentation of this academic year. The Speaker Series returns in October!

First Year Talks

Wednesday afternoons on 2, 9, 16, 23 and 30 May 2012

Talks by the first year PhD students introducing their work to the department will be held in LT1 at Pembroke Street. Tea and cakes will be served during each set of talks and there will also be a drinks reception and prize giving at the end of talks on the 30 May.

CEB Pub Nights

There are two Happy Hour and Pub Nights to look forward to this term. Come along to the Tea Room for drinks and snacks followed by the usual pub gathering (location TBC).

Friday 11 May 2012, 5.00pm

Hosted by the Bahn Group (Frieder Haenisch and Andreas Albrecht led)

Friday 8 June 2012, 5.00pm

Organised by the Powder and Paste Processing Group (Amanda Talhat led)

CUCES BBQ

Set to happen in **June**, hosted by the New CUCES Committee.



CEB New Director of Teaching



Dr Patrick Barrie has become Deputy Head of Department (Teaching), taking over from Dr David Scott as Director of Teaching.

Patrick obtained his Bachelors degree in Natural Sciences and went on to obtain his PhD in Physical Chemistry at Cambridge in 1991. After

a spell as a research fellow at University College London, he returned to Cambridge and is currently a Senior Lecturer in the Department. He is a Fellow of Emmanuel College.

Patrick's research interests are varied, but have usually been related to the behaviour of molecules in porous solids with applications in the field of applied catalysis. He is particularly interested in methods for obtaining physically meaningful parameters from experimental data that can then be used for modelling processes.

Patrick has been involved in the administration of undergraduate teaching for a number of years, dealing particularly with admissions and quality assurance issues. The high quality of his lecturing earned him a Pilkington Award for Teaching back in 2008.

Patrick has already started planning the undergraduate teaching for the next academic year. His aim is to ensure that we aspire to excellence in teaching as well as research.

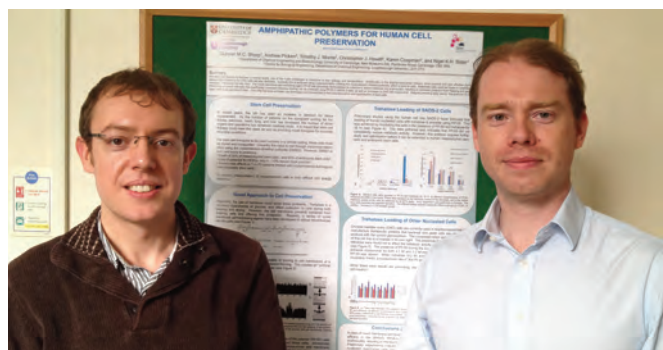
Head of Department, Professor Nigel Slater congratulated Patrick and thanked his predecessor: "Welcome to Patrick and very sincere thanks to David for his immense contribution over many years and the acclaim that this has won the Department."

BRIC prizes awarded to our BioScience researchers

Recently the Bioprocess Research Industry Club (BRIC) and the British Biosciences Research Council (BBSRC), which invests in world-class bioscience research and training on behalf of the UK public, held a dissemination event in Leeds on 7 and 8 March. This was a forum for bioprocess professionals to view and discuss academic research projects with a view to applying these projects in industry. At this conference both Dr Nicholas Darton and Dr Duncan Sharp from the CEB BioScience Engineering group led by Prof Nigel Slater, HoD, won both conference prizes.

Dr Nicholas Darton won the prize for best presentation on his research into *Fast ion-exchange separations in a Disposable Plastic Microcapillary Disc*. In this research microcapillary film was engineered for use in the biopharmaceutical industry for the high speed separation of monoclonal antibody therapeutics. During the course of this work the platform technology developed was also applied to the synthesis of radio-therapeutics and in the capture of lentiviral vectors for use in gene therapy.

Dr Duncan Sharp won the prize for best poster for his poster entitled *Amphipathic Polymer for Human cell preservation*. His research has focused on the use of novel cell membrane permeabilising polymers to deliver non-permeating cryo/lyoprotectants into human cells. Potentially this could lead to improved stem cell cryopreservation methods, reducing losses in both cell viability and functionality. In addition, this approach could make the preservation of stem cells by lyophilisation a reality.



Dr Nicholas Darton and Dr Duncan Sharp with the winning poster

The Value of a Chemical Engineering Education

John R Potter (Class of 1959)

My first problem was to choose between studying Chemical Engineering and a career in the RAF. I joined the RAF for my National Service in May 1953. Meanwhile, my place to study for a degree at Peterhouse Cambridge was kept on hold for two years. I passed through full Pilot Training and this enabled me to join 504 County of Nottingham Squadron of the Royal Auxiliary Air Force – the “weekend pilots”. I became an active member of the squadron – mainly during my vacations. In 1957, my flying days came to an end as the R.Aux.A.F. ceased to fly and we were disbanded. I had already decided to take the Cambridge University 2-year Chemical Engineering course after two years Natural Sciences.

In 1959, I joined the Research Department of ICI on Teesside in what became the Agricultural Division. Sid Andrews, my manager, had decided that he needed Chemical Engineers to learn to program the computer so that the Chemical Engineer had direct contact with the computer rather than needing to pass requests, information and data through a programmer – a wise decision at that stage in the development of computers. I worked on simulation of the Ammonia reaction process, Steam Reforming, Methanol and other processes for about three years. ICI had developed a low-pressure catalyst for methanol and I was a co-patentee of a new design for the internals of the reactor.

My next role was in plant management of the Steam Reforming Plant and the development of the Methanol plant. I was then promoted to Section Manager of the Fertiliser Section in the Research Department – comprising about 30 staff.

It was a very lively period at Billingham and I had been there for over seven years when I was invited to visit the contracting company, Humphreys and Glasgow, in London. My wife and I had several reasons for thinking we would like to move south and so I accepted an appointment as Business Development Manager at H&G in the middle of 1967. As well as Business Development, I was responsible for the Laboratory and a small Patents Department. In addition, we carried out

studies and consulting work where projects had not yet “reached the drawing board”. At H and G, I spent a considerable time on travelling, attending meetings, consultancy work, papers etc.

One of the major projects I lead was a study for UNIDO of the potential in the then East and West wings of Pakistan for developing fertiliser and petrochemical projects. The work went in a number of stages and lasted nearly a year. One aspect of the study was to balance the developments sensibly between the two wings. About six months after the end of the project, the two wings became Pakistan and Bangladesh!

We also carried out a somewhat similar study in Venezuela, again including petrochemicals and fertilisers and taking into account raw materials in the country. On the day I was about to leave Caracas for home, I received a phone call from the MD. He announced that a pharmaceutical project was coming up in Bolivia and suggested that I make a visit there – on my way home!



The Famous Monolithic Gateway

It just so happened that it was Carnival weekend in South America and that gave me four days to get to La Paz. I flew to Cusco via Lima and on the flight to Cusco I sat next to a Spanish nun who was also by herself, so we had dinner together. It was fairly cold and she had no socks so I lent her a pair. The next day, I was off on

the 7a.m. train to Lake Titicaca taking all day climbing to over 15,000 feet – almost the snow line – and then running through the Altiplano to the Lake in the afternoon. The steamship, built in the UK in 1927 and reassembled at the lake, set off at about 8 p.m. and arrived at the Bolivian end of the lake just as dawn was breaking. I got to La Paz by train about midday on Monday. The next morning I had my meeting and started my journey home with a flight to Lima. No business arose from the visit but such is contracting!



*Enroute from Peru to Bolivia
(Source: By boat-train through the Andes, J.R. Potter)*

After 4 years at H&G, I was invited to join a company at Gillingham Kent, which had about 100 staff and manufactured stainless steel pressure vessels and had a small contracting section, which mainly supplied complete units including the vessels made in the factory. The two owners of the business were planning to retire and the Steel Brothers Group based in Dorking acquired it. I was appointed Managing Director and Chairman of the business renamed Steel Brothers Process Plant Limited. (Steels already had a number of smallish engineering companies representing about a tenth of the Group.) The company manufactured both stainless steel vessels and carbon steel vessels clad internally with stainless steel. Of the latter type, a major project was the manufacture of seven vessels for a new Polypropylene plant in Brazil, which was financed by Lloyds Bank. These vessels also contained internally large stainless steel heat transfer panels, which were very highly polished.

During this period I was very nearly high jacked. A colleague at Dorking asked me to travel with him to

Australia at short notice to investigate a business opportunity. He booked us on an earlier BA flight. However, he could not get First Class for such a long flight and I changed us to another flight 2 hours later. The BA flight was high jacked to Libya!

Around this time, 1977, Steel Brothers decided to form a holding company and transfer the engineering companies into the new holding company. At this stage, I was appointed Chief Executive of the Engineering Division. My new responsibility brought down my association with work of a Chemical Engineering nature to less than 15% and increased my responsibility to about 1000 staff, with the companies ranging from about 15 up to 500 staff, the latter being in the mining engineering company. It was, however, a very interesting group of disparate engineering companies in England, Holland and Germany. With now only about 15% involving Chemical Engineering, I will turn more briefly to the second, slightly longer half of my career.

My appointment with Steel Brothers came to an end in 1986/7, when there was new senior management in the Group and also the flavour of the time was “Concentration on Core Businesses”. The various small engineering companies clearly did not represent a core business! We gradually sold the individual engineering companies over a period of about a year and I started to look for a new appointment. Firstly, I was asked to carry out several consultancy projects, while investigating new employment prospects.

Further consultancy work came to me from another ex-RAF and Cambridge University colleague, who owned a sizable business primarily in central heating. He also acquired a Dutch company manufacturing copper tube for heating systems and I was asked to make regular visits to liaise with the Dutch Management. Then, over a year or so, my time became almost fully used with work in various sections of the UK Company, of which I became an employee from 1994 until my gradual retirement in the first year or so of the new Millennium.

Oh, just a minute, I need to make the coffee! (And, by the way, my socks did not reappear – no doubt inadvertently!)

Life across the Pond

Amanda Taylor



I moved to Cambridge from America in September 2007, when my husband, Ben, was accepted here as a PhD student. In one crazy flurry of activity, we sold our home, our vehicles, and I left my teaching job of six years to cross 'The Pond'. I'm so glad we did!

In addition to my wonderful job as the Research Secretary here at CEB, I've loved all the travelling we've been able to do. When in high school, I had a delightfully quirky history teacher who really sparked my interest in both British and European history, and I

continued the study while at Uni. I couldn't wait to go travelling around to visit all the places I'd only read about; for me, Europe is like Disney Land!

One of my goals when leaving America was to fill my passport with stamps of the countries I've visited. I'm happy to report that I've done so well, I had to have extra pages added! Plus I've managed to cross a few things off my Bucket List: The Coliseum, The Eiffel Tower (we took the stairs!), spending the night in a castle, German Christmas Markets and Augsburg (where Ben was born) and strolling along the canals of Venice. I still need to kiss the Blarney Stone, though!

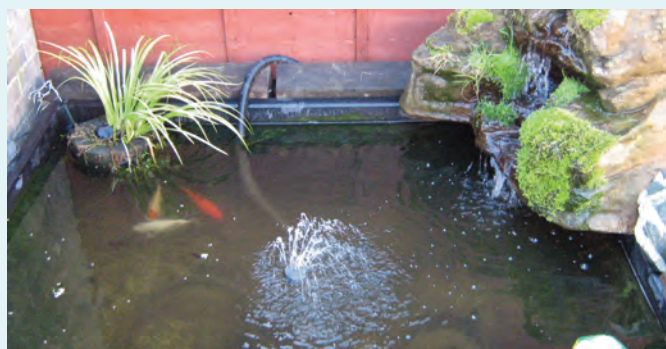
I've made so many friends from all over the globe and from all walks of life. While I still miss many 'Americanisms' like Thanksgiving and football (American football, that is!), I wouldn't trade my time here for the world.

Passion for Restoration

Roz Williams

Chief Teaching Laboratory Technician

My main hobbies and interests outside work include hard landscape gardening and motorcycle restoration. The images show my back garden, for which I used entirely recycled or reclaimed materials. The majority of the wood was formerly groynes from the seaside. The rhododendrons (sadly not currently in flower, as too early in the year) are planted in four tonnes of ericaceous topsoil that I had delivered. The fish shown here used to be in a tank in the Teaching Lab, and they had 27 babies last year!



My motorbike is a 30 year old Z1000, upon which I have lavished a great deal of time! As you can see, it is not yet finished, but the engine has been overhauled, polished and painted, and I have restored the tank, side panels and tailpiece and had them professionally re-sprayed in iridescent purple. I shall be taking it to work to show it off, when it is complete.



Prof Francis Gadala-Maria



Visiting Academic

University of South Carolina

Prof Gadala-Maria first visited CEB in 2004, when he collaborated with Prof Malcolm Mackley and Bart Hallmark, his graduate student at that time, on microcapillary films. His time in the department was so enjoyable and productive that when he was again eligible for a sabbatical leave, his choice was clear. This time he is collaborating with Dr Ian Wilson and Dr Bart Hallmark, now a Design Lecturer, on the rheology of bubbly liquids, that is, liquids with suspended gas bubbles. This area complements well his expertise on the rheology of suspensions, which are liquids with suspended solid particles. The two types of material are similar in some ways and very different in others; unlike solid particles, bubbles are compressible, deformable, can coalesce, and the gas from which they are made can diffuse into the suspending liquid and vice versa. Prof Gadala-Maria finds Cambridge a beautiful place and the academic environment very stimulating. He particularly enjoys the interactions with faculty, staff, and students in the department and in Robinson College, where he has been appointed a Senior Member.

Christian Guyader



PhD Student

Bioscience Engineering Group

Having grown up in Belgium with Franco-Danish roots I came to Cambridge to study for my undergraduate and graduated from the department with a MEng in June 2011. Having had an amazing time here as an undergraduate and having an offer for a very interesting project, I decided to stay for a PhD. I therefore returned to Cambridge in January after having spent four months travelling around South America. Since June, a lot of the faces in College have changed but the department was more or less how I had left it and I easily fell into place in Prof Slater's welcoming group, where I had also done my Part IIB project. One of the major differences from being an undergraduate here is that I am now on the other side of the supervision table, trying to teach the undergraduates - hopefully successfully! My PhD project focuses on the development of a peptide based vector for the delivery of genes into human cells in the field of gene therapy. I think this is probably the greatest contrast to my undergraduate life, having my own project in a field I really enjoy!

Dr Kyung-Min Song



Technology Information Manager *Samsung Advanced Institute of Technology*

After spending five years in the department through MPhil, PhD and Post-doc I feel I have achieved a lot with excellent teaching, research and support. The MPhil ACE course is such a fantastic and unique course where chemical engineering subjects are mixed well with the business subjects. Back in 2006-7, there were only 13 of us from 12 different countries which gave us the feeling that we were the representatives of our own countries. I am happy to see that the numbers are growing each year. I also very much enjoyed my PhD and post-doc projects working with MRI, all thanks to my supervisor, Prof Lynn Gladden, and everyone in CEB. I will remember Cambridge not just for the academic achievements and the blades won in May Bumps, but (with equal importance) as a place where I started my family and met fantastic people and lifelong friends. For all these reasons, I can say that my time in Cambridge has undoubtedly been the most valuable time in my life. I am currently at Samsung Advanced Institute of Technology in London and I hope to contribute back to the Department in the future.

Dear Dr Sarah...

As a PhD student I spend so much time working on my really specific research question and it can start to seem quite lonely and meaningless in the larger scheme of things. How do I convince myself that my project is important to anyone else other than me?

*Many thanks,
Increasingly Isolated*

Dr Sarah says...

I'd like to answer this by telling you a tale, if I may.

One birthday, I decided to treat myself to a new dresser; one where I could store all my favourite things, such as eyeliner, jewellery, black pointy hats, *etc.* May as well get a huge one, I thought (I have a lot of eyeliner), fabricated from the obligatory pinewood, the stuff you just have to look at and a dent appears in it. And to make my birthday even more memorable, I decided to procure the furniture flat-packed. Now, I'm the first to admit that I'm no DIY expert, but I do know which way to turn a screw in order for it to disappear into a hole. But I swear you need a degree in etymology in order to understand instructions such as "attach to right side with hole B using medium screw C on left board 2 horizontal, round edge up, in with notch on board 3." Anyway, in the end I just followed the pictures, holding various pieces of wood in place with my toes whilst I tried to screw them together at right angles to each other.

So after much toil, and a few slices of birthday pannetone (to aid morale), I had the skeleton, which I carefully moved into position. (Note to self: always assemble large items of furniture as near as possible to their final resting place.) I inserted the drawers, attached the hinged doors, and filled it to capacity. Not only did it look great (the bits that I didn't quite get flush were luckily at the back, facing the wall), but it also performed suitably well as a storage facility. I was pretty pleased with myself. So I had another slice of cake.

One day, a month or so later, I was doing a bit of cat hair-removal from the floor near the dresser when I espied a small silver-coloured ball, approximately 3mm in diameter. Hmmm, what's this? Maybe one of the cats brought it in between their paw pads. Thinking nothing of it, I threw it away. And then a couple of days later another one appeared. Perhaps I should keep it this time – it may be a gift from the House Pixie – so I opened the dresser drawer and whoosh! a load more spewed out onto the floor, the point of source being a broken drawer runner. But there's still a groove in the side of the drawer, so why do I need a runner full of little ball-bearings? The drawer will fit in nicely *au naturale* ... screeeech.

Now I only keep totally useless things in that drawer, such as my TV licence, a bottle of suntan lotion, and a 'Jools Holland and Friends' CD, just so I don't have to open it more than once a year.

And there you go – as above, so below

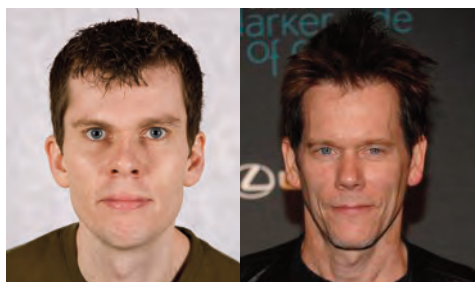


Dr Sarah, with eyeliner, trying to work out the meaning of it all...

Do you have a question for the Doctor? Send in your chemical engineering dilemmas to ceb-focus@ceb.cam.ac.uk for Dr Sarah to address in the next issue.

Welcome to the new look Teatime Teaser!

We hope you enjoy the local look-alikes which were all sent in by our readers and our CEB crossword (solutions available online). Please send us your suggestions for future issues at ceb-focus@ceb.cam.ac.uk



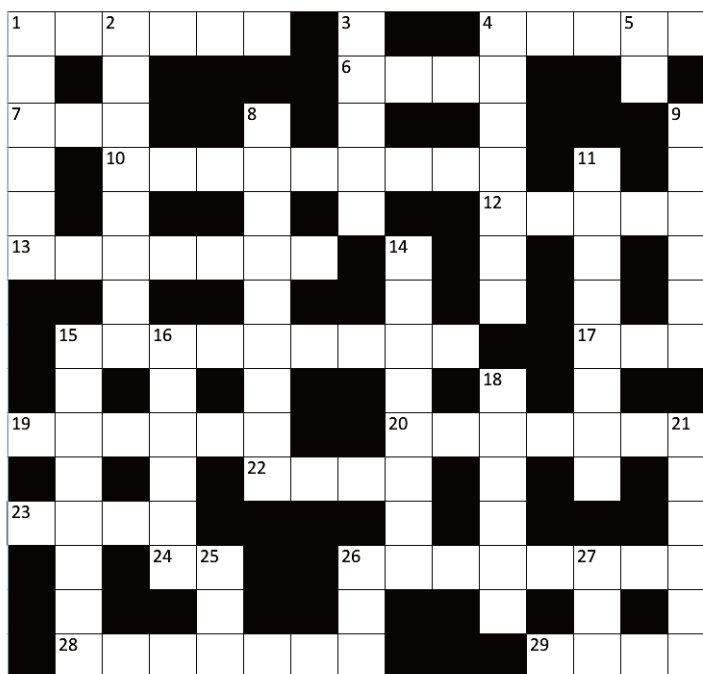
Dr James McGregor and Kevin Bacon



Dr Geoff Moggridge and Gary Sinise



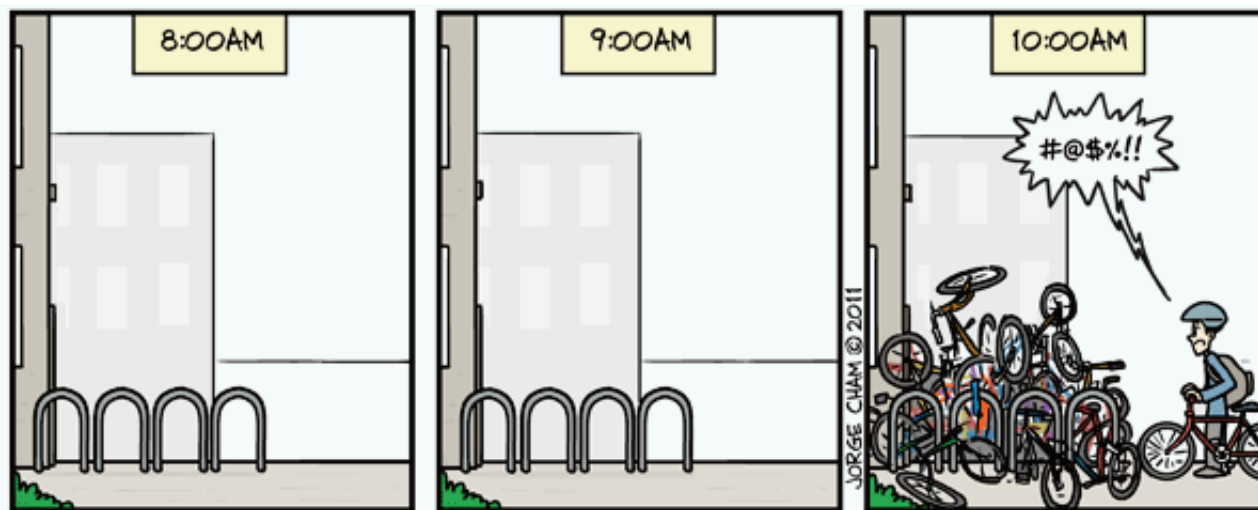
Prof Markus Kraft and Bunsen Honeydew

**Across Clues**

1. Gas, liquid and solid (6)
4. HoD (5)
6. Type of electron pair (4)
7. 21% O₂ (3)
10. Periodic table part - aid insect (anagram) (9)
12. Bond type (5)
13. Stir (7)
15. Has low thermal conductivity (9)
17. Oil sands (3)
19. Organism's hereditary info (6)
20. Solvent (7)
22. Stagnant area in reactor, _-zone (4)
23. Channel for conveying exhaust gases (4)
24. Antimony (2)
26. Dimensionless characteristic (8)
28. C₁₂H₂₂O₁₁ (7)
29. Amount of substance, SI unit (4)

Down Clues

1. Ionised state of matter similar to a gas (6)
2. Rough area (8)
3. Deforms under an applied shear stress (5)
4. Temperature (7)
5. System of units (acronym) (5)
8. Separated (9)
9. Has magnitude and direction (6)
11. Microscopic unit of length (8)
14. Famous number (8)
15. PV=nRT (5,3)
16. Integration theorem (6)
18. Elementary particle (6)
21. Natural catalyst (6)
25. 705.06 Torr (3)
26. π ? (3)
27. Equal (prefix) (3)



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Letters to the editor

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