UNIVERSITY OF CAMBRIDGE

CEB *Focus*

Department of Chemical Engineering and Biotechnology

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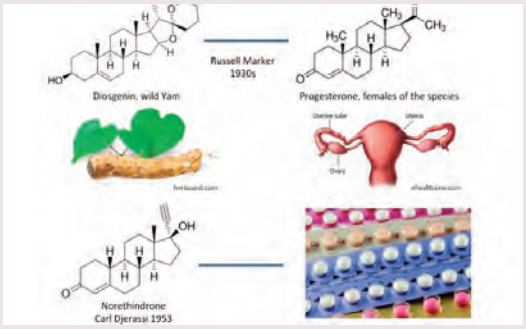

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In this Issue

Welcome

Message from HoD, Professor John Dennis

Since the last issue of *CEB Focus*, I am pleased to announce that CEB has been successful in its application for an Athena SWAN Bronze Award. Athena SWAN is a Charter which encourages and recognises commitment to advancing the careers of women in all subjects. Its Bronze, Silver and Gold awards celebrate good practice in recruiting, retaining and promoting women within Higher Education. The application for the award was prepared by a sub-group of the Department's Athena Swan Working Group, to address issues discussed by the group and raised by staff (for example, via the 2015 Staff Survey). The application involved a rigorous and thorough process of self-review of the Department with respect to areas of good practice, as well as areas of improvement, and the development of an Action Plan to ensure the Department can progress its equality agenda.

Whilst the CEB staff and student gender balance is favourable in comparison with key national benchmarks, we shall strive to do more. The Athena Swan Working Group continues to meet on a regular basis to drive forward the actions outlined in the Athena Swan application, and to continue to promote and develop a positive and inclusive work and study environment for everyone. The challenge now is to continue to enact the Action Plan to which we have committed and so to progress to the Silver Award.

The Award was presented at a ceremony held at the University of Liverpool on 12 December, 2016, attended by Ms Emma Frampton and Dr Tom Matthams.

Finally, the move of the research activities to the new building at West Cambridge will start in mid-March. This will complete the removal of the Department from its premises in Pembroke Street and Tennis Court Road.

Editorial Note

CEB Editorial Team: Chief Editor Elena Gonzalez (centre) with Geertje van Rees, Dr Parminder Kaur Heer and new member Sukanya Datta (far right) and Aazraa Pankan and CUCES Publicity Rep Pawat Silawattakun (far left)

The Editorial Team wishes its global readership a fantastic 2017! *CEB Focus* Newsletter is the product of a joint team effort led by Elena Gonzalez assisted by volunteer editors. We would like to welcome back Noha Al-Otaibi, now returned from maternity leave, as well as introduce the latest member to join the Editorial Team, Sukanya Datta, a PhD student from Nano Doctoral Training Centre program (NanoDTC) in Dr Laura Torrente's Catalysis and Process integration Group. We are always keen to see new faces and, if you are interested in joining, please email us on ceb-focus@ceb.cam.ac.uk. Each member is fully committed to the project and its timely delivery. Individual and team effort and contribution of enthusiastic ideas is ahugely valuable as it is crucial to the editing process and the publication release and helps develop the quality of the editorial content and the publication look.

The *Main Article* focuses on CEB officially receiving the Athena SWAN bronze award in recognition of the Department's commitment to help advance the careers of women in science. *Undergraduate Focus* shares students' insights into the value of careers events and the need for early student-industry liaison. Graduate Hub features Dr Brubert's "Dancing your PhD" win, Editorial Member Sukanya's stint teaching computer education and entrepreneurship in India and Markus Fantham's scientific innovation film production for Cambridge Shorts.

Industry Business offers an overview of the latest exciting industry collaborations and developments, with MedImmune awarded a BBSRC Biotechnology collaborative partnership with CEB and Dr David Fairen's new spin-out company Tarsis Technology Ltd. *Research Highlights* features the UK Fluid Network Interest Group launched by Professor Ian Wilson as well as Junior Research Fellow and alumnus Chris Ness' research focus. In the *Research Feature,* Dr Alessio Zaconne tells about the main research activities of the Statistical Physics Group whilst *CEB Innovation* features a report by alumnus Dr Nuno Reis' on the latest technology developments around multi-capillary films and its applications and alumnus Dr Darrin Disley's Horizon Discovery product "Turbo GFP tagged HAP1 Cells", named among the 'Top 10 Innovations'.

CEB Women celebrates the achievements of Department female "Rising Stars" named in the "50 Movers and Shakers in BioBeat 2016 Business" report: Professor Sabine Bahn, alumna Dr Ipshita Mandal and PhD student Theresa Maier. Worth noting too are the latest series of *Achievements* - the NSERC Scholarship going to Dr Nick Eaves, the Energy Catalyst awarded to David Fairen for his research into gas separations, also recently awarded the European Research Council (ERC) grant of €1.9m for his Design of NanoMOFs, along with Dr Jacqui Cole's award to develop solar-powered windows and a £1.5m grant given to Dr Laura Torrente to help reduce industrial energy demand in the UK.

Alumni Corner features 2009 Chemical Engineering graduate Dr Abhishek Deshpande, recently awarded the "Energy Executive of the Year" by Petroleum Economist, who reports on changes in his career path so far. *Staff Room* features an interview with Sabina Bryant, CEB's new Administrator. Finally, please note that, from now on, the *Events* section will include a review of former events, as well as a list of upcoming events. Special thanks to webmaster Vanessa Blake for regularly providing photos, and to department members, alumni and corporate partners for sending article contributions.

CEB collects Athena SWAN Bronze Award

Dr Miriam Lynn, Equality & Diversity Liaison for the School of Technology

Emma Frampton (HR Adviser, middle) and Dr Tom Matthams (Academic Secretary, right) receiving the award from Athena SWAN patron Sir Paul Nurse (Director Francis Crick Institute, left)

Higher education mirrors the general UK workforce pattern whereby women are usually well represented in universities as a whole, in fact there are more women employed at the University of Cambridge than men, but there is a lack of women in senior positions, particularly in academic posts. The Athena Swan Charter is a process where Departments take a critical look at themselves and start to work out ways in which practical change can be implemented to bring about advancement in diversity and inclusion. What is interesting and relevant is that individual Departments write their own action plans, carry out interventions and measure themselves against their own plans.

The Athena SWAN[1] Charter was established by the Equality Challenge Unit (ECU) in 2005 to encourage and recognise commitment to advancing the careers of women in STEMM employment in higher education and research. It recognises the advancement of gender equality: representation, progression and success for all, and as of May 2015 the charter was expanded to recognise work undertaken in arts, humanities, social sciences, business and law (AHSSBL). The charter now recognises work undertaken to address gender equality more broadly and not just barriers to progression that affect women.

Obtaining the Bronze award means that CEB has successfully analysed quantitative and qualitative data relating to gender and promotions, attainment, levels of satisfaction and has assessed where its at in relation to advancing the careers of women within the Department. The award also recognizes that the three-year action plan, created by CEB to further equality and celebrate diversity within the Department, is deemed to be achievable and fit for purpose.

A key strength of the Athena SWAN process is that it facilitates more collaborative work both within and across the University. CEB has been engaging with staff from across the University, including a number of Equality and Diversity Consultants from the Equality & Diversity section as well as hearing from other Departments about their successes.

A recent evaluation of the Athena SWAN Charter (carried out by Loughborough University) highlights that the most important actions taken since receiving an Athena SWAN departmental award were:

- enhanced communication within the Department concerning equality and diversity matters, in particular the sharing of survey findings and proposed solutions
- enhanced support and encouragement for women academics to apply for promotion
- ensuring the voice of postdoctoral researchers was heard and acted upon

We know that gender inequality within Engineering starts before young people choose their University degree courses. Out of 1000 11 year olds, 111 boys and 101 girls will achieve a physics GCSE A* - C, 44 boys and 13 girls will achieve a Physics A'level and 21 males and 3 females will obtain an Engineering or Technology degree (Engineering UK). There is much to do to encourage the progression of girls and young women into Engineering and CEB is only a part of the jigsaw puzzle.

As the School of Technology Equality & Diversity, I can honestly say that it is an exciting time to be supporting CEB and their Athena SWAN action plan. I plan to develop ways in which I can support you to look at Implicit / Unconscious Bias and to find new and creative methods to making CEB even more inclusive and diverse for everyone.

[1] Miriam Lynn is the Equality and Diversity Liaison for the School of Technology supporting CEB with its E&D initiatives. See her contact details on www.equality.admin.cam.ac.uk/contact-us

ATHENA SWAN FACTS

Athena SWAN Charter for women in science
Recognising commitment to advancing women's careers in STEMM academia

Athena SWAN is a Charter to advance women's careers. It's Bronze, Silver and Gold awards celebrate good practice in recruiting, retaining and promoting women within Higher Education.

The Charter covers women (and men where appropriate) in:
- academic roles in all academic disciplines
- professional and support staff
- trains staff and students

And in relation to their:
- representation
- progression of students into academia
- journey through career milestones
- working environment for all staff

The Charter has ten principles at its core, the benefits of which include retention of highly valued female staff, access to a network of contacts, and external recognition of positive action already taken. By being part of Athena SWAN, institutions are committing to a progressive charter; adopting these principles within their policies, practices, action plans and culture.

1. We acknowledge that academia cannot reach its full potential unless it can benefit from the talents of all.
2. We commit to advancing gender equality in academia, in particular, addressing the loss of women across the career pipeline and the absence of women from senior academic, professional and support roles.
3. We commit to addressing unequal gender representation across academic disciplines and professional and support functions. In this we recognise disciplinary differences including:
the relative underrepresentation of women in senior roles in arts, humanities, social sciences, business and law (AHSSBL)
the particularly high loss rate of women in science, technology, engineering, mathematics and medicine (STEMM)
4. We commit to tackling the gender pay gap.
5. We commit to removing the obstacles faced by women, in particular, at major points of career development and progression including the transition from PhD into a sustainable academic career.
6. We commit to addressing the negative consequences of using short-term contracts for the retention and progression of staff in academia, particularly women.
7. We commit to tackling the discriminatory treatment often experienced by trans people.
8. We acknowledge that advancing gender equality demands commitment and action from all levels of the organisation and in particular active leadership from those in senior roles.
9. We commit to making and mainstreaming sustainable structural and cultural changes to advance gender equality, recognising that initiatives and actions that support individuals alone will not sufficiently advance equality.
10. All individuals have identities shaped by several different factors. We commit to considering the intersection of gender and other factors wherever possible.

More info on www.ecu.ac.uk/equality-charters/athena-swan/about-athena-swan/ and Athena SWAN in Cambridge on www.equality.admin.cam.ac.uk/files/as_4pp_a6web.pdf

Careers Panel Event

Pathorn Achakulwisut, CUCES Secretary 2016-17

Alumnae Amanda Chen, Pepsico (middle) and Rikita Sood (far right) with undergraduates

On Tuesday 8 November, the annual CEB Careers Panel event was held at the West Cambridge site. This year, it was interesting to see representatives from a wide selection of companies working in different industries, from Shell on working within oil & gas, P&G on consumer goods, and GSK on pharmaceuticals.

These events are always beneficial to undergraduates at all levels. The best way to learn about a particular company is to hear about it first hand from the people who have actually been working there. Hearing about the career paths each person has taken, and the various choices they have made through life, which has resulted in their present position, exemplifies the importance of searching for the kind of career which suits your needs and abilities best. Hence, having more information about a particular industry at an early stage, and the upsides and downsides of a particular job, by attending these sorts of events will help students to build a clearer picture for what they want to do after they graduate. It was particularly helpful that most of the representatives were actually alumni of our Department!

Introducing the new Part I Rep

Julia Allford

As the CUCES Committee's newest member, and the current Part I representative, it is high time I introduce myself to the whole department. I am a former Natural Scientist, one of ten (!) part I Churchillians, and my favourite part of changing to Chemical Engineering is the free tea provided at department-wide tea times! Joking aside, I find the tea breaks do embody one of the most important aspects of the Department - it is a friendly, welcoming, family. Coming from lectures of 500 students to an entire department smaller than that made a much larger difference than I'd expected. I have been able to meet, and actually get to know, so many new people across all the years, not just my own. The lecturers and departmental staff are approachable and welcoming and have made the transition between first and second year easy.

All the staff have also worked tirelessly in ensuring the move from Pembroke Street to the new Department was as smooth as possible. The new facilities and buildings have further enabled socialising alongside providing numerous productive work spaces.

This term I have enjoyed organising the CUCES Christmas Dinner, career panels and meeting prospective chemical engineers. The Committee is friendly, and I enjoy being part of the team. I look forward to our annual dinner, Frank Morton and the many career events and socials we have lined up this term.

Frank Morton Games Return!

Vid Mehta, CUCES Social Secretary 2016/17

Every February, Chemical Engineering departments from across the UK and Ireland come together to compete in various sporting activities, meet with representatives of some of the field's biggest employers, and have fun. It all started in 1961, when Professor Frank Morton (known for his eponymous number) organised a football match between his previous and current Chemical Engineering departments (Birmingham and Manchester respectively) and the event has only got bigger since .

The sports have historically ranged from the standard games of football, basketball, and squash to more odd choices such as benchball, quidditch, and bowling. Cambridge University came an impressive sixth place overall last year, being champions in benchball and chess. This year the competition is being hosted in Loughborough and will hopefully prove to be a lot of fun.

Source: www.facebook.com/IChemE.FrankMortonSportsDay

CUCES Christmas Dinner 2016 Sponsored by BP and GSK

Pawat Silawattakun, CUCES IT & Publicity Officer 2016/17

'Twas the eighth Thursday of Michaelmas Term (24 November) when CUCES Christmas Dinner 2016 was held. The venue was Browns – our favourite brasserie & bar in Cambridge – and this year we had about 70 people attending, including Undergraduates across all year groups, two BP Reps (Philip Mak and Patrick Davies), two GSK Reps (Sam Wibberley and Laetitia Thuysbaert), and (of course) the popular lecturer Carmine D'Agostino.

CUCES arrived at Browns early to sparkle up the tables with glitter stars and hand-label guest names on the wine. The Christmas crackers were laid up next to the festive name place cards. Guests were warmly welcomed at 7 p.m. with a complimentary glass of sparkling wine. At 7:30 p.m. we were seated, and we all enjoyed a lovely exclusive three-course meal. A special shout-out goes to our new Part I Representative, Julia Allford, who single-handedly made from scratch the heavenliest of gingerbread biscuits with a message for everyone.

The CUCES Committee would like to thank both BP and GSK for sponsoring us, making it possible for us to organise such a fantastic end-of-term event for our Department.

For more information on a career with BP and GSK see www.bp.com/en/global/bp-careers.html and www.uk.gsk.com/en-gb/careers

The CUCES Committee at Christmas Dinner. (Credits: Dylan Lim)

Michaelmas GradSoc Events

Visit at the brewery

During Michaelmas 2016, the Graduate Researcher's Society organised three great events for the graduate students of CEB. We kicked off the year with an amazing brewery tour at the Milton Brewery in Cambridge, where 23 students discovered the craft of brewing and they were able to taste various kinds of delicious ales and other beers.

Halfway through the term, 5 students visited Jesus College for a formal dinner, followed by drinks at the bar. Finally, the term ended with our amazing Christmas party organised together with the PostDoc committee with free mulled wine and snacks, plenty of Christmas carols and of course the Secret Santa presents.

The purpose of the GRSoc is to promote collaboration and guard the graduate students' welfare and organise social events. The GRSoc committee is composed of students from different research groups and research sites of the Department, as well as from the different graduate courses offered. We still have many more exciting activities planned for the next terms, such as our yearly PhD conference with BBQ, a whiskey tasting event, a bowling party and a pizza/movie night at Churchill College. If you have any ideas on events that you want to be organised, contact us on grsoc@ceb.cam.ac.uk

Believing is Seeing

A scene from the video

Over the summer Marcus Fantham, a PhD student in the Laser Analytics Group, made a short film for Cambridge Shorts, a project organised by the University Publicity Office "to support early career researchers to make professional quality short films with local artists and filmmakers." It got premiered at the Arts Picturehouse, and was released on Youtube on 7 November 2016.

Marcus describes the video as *"A long time ago, in a galaxy far, far away, a nanotechnologist and an art historian sat down and asked a question: what does the imagination have to do with a scientific innovation? The visual imagination is not simply frivolous. It is utterly vital to understand the scientific and technological developments, which have allowed our society to evolve, both historically and in the present day. This is a love letter to scientific daydreaming; to the importance of creativity in science; to the old-school sci-fi classics and the way they captured the imagination. This is about the art of being a scientist."*

See the video on www.youtube.com/watch?v=SNe65oJsOos

"Dance Your PhD" Win

Dr Jacob Brubert

Showing a functional heart valve on Queens' mathematical bridge in the opening scene

'Dance Your PhD' is a worldwide competition run by Science and the American Association for the Advancement of Science (AAAS). The idea is to convey

your PhD research through the medium of dance.

Jacob Brubert completed his PhD in this Department and his entry explains the engineering of a prosthetic heart valve. It is based upon his PhD thesis entitled "A novel polymeric prosthetic heart valve: design, manufacture, and testing", and his dance won the overall prize! He won $1000 for his effort and a trip to Boston in February for a screening and talk at the AAAS annual meeting.

The dance tells the story of "A polymeric prosthetic heart valve", opening with the failure of a diseased heart valve, as represented by a shot of three dancers suspended from the Mathematical Bridge at Queens' College.

Currently, a surgeon can replace the diseased valve with one of two types of prosthesis: a bioprosthetic valve made from animal tissue — as represented by a pair of salsa dancers. Or a mechanical valve with rigid leaflets, demonstrated by two tap dancers. The bioprosthetic valve is well tolerated by blood, but the durability is limited. Conversely, the mechanical valve is poorly tolerated by blood and requires lifelong anti-coagulation, but the valve is durable enough to outlive the patient.

Brubert recruited 18 willing volunteers to dance and film the extravaganza, which he produced over 4 weeks last summer. *"We finished every scene in stitches of laughter, and had great fun!"*. He only had one regret, which is *"not finishing it in time to show at my viva!"*.

You can find the video on www.sciencemag.org/news/2016/10/and-winner-year-s-dance-your-phd-contest

Tackling Digital Literacy in India

Sukanya Datta 1st year PhD student, Process Integration group

Access to computers and technology is very limited in developing economies like India. In rural villages of India, it is even more important to make people understand the power of embracing digital literacy and education because not only the white collar jobs depend on computers but the productivity of the blue collar jobs can also be increased with technology. An effort was made by Sukanya Datta to bridge this "digital gap" between children from rural and urban backgrounds.

To address these issues, they established the (L)earn program which is part of a wider intervention initiative in computer based education for the developing world, led by Madanyu Social Enterprise and Agastya International Foundation (Indian non governmental organisation). During the months of August and September in 2016, Sukanya had the opportunity to work as a volunteer for Madanyu working with Agastya Foundation, based in Bangalore, India, to teach students from rural villages of India for two weeks. The aims of the (L)earn program were two-fold:

1. Imparting entrepreneurial skills to students so that they are able to recognise any potential business opportunity they may come across;
2. Developing their digital skills to improve their employability and job prospects in life.

Each (L)earn module was designed over 5 days in a week (approx. 20 hours in total).

Within this time she was able to complete two pilot programs successfully. This program was delivered to a total of 40 students in two villages in the age groups of 10-12 years. The objective was to introduce basic entrepreneurship skills to students along with digital literacy. Sukanya says *'It was a true pleasure to view the interest of students and their high level of motivation'.*

Sukanya Datta and the children following the (L)earn programme

Review of New Part IIB Module - Interface Engineering

Professor Ian Wilson, Professor of Soft Solids and Surfaces

Wine legs inside a wine glass[1]

Why does oil spread on water and not the reverse? Do the 'legs of wine' on a wine glass indicate the quality of the wine? Is there a difference between surface tension and surface energy? Is there a limit to the size of a water strider and other insects that can walk on water? These important questions (and several others) were addressed as illustrations in the new CET IIB Module on Interface Engineering taught in the Michaelmas Term.

The unofficial title of this module was 'Surface Tension Engineering'. Surface tension is the force, which arises at the interface between liquids and air, between immiscible liquids and between a solid and a fluid. Phenomena arising from surface tension are important at small length scales, for instance in microfluidics, biomedical interfaces and nanotechnology. They also arise in particle technology and in cleaning, areas in which Ian Wilson has been working for many years and Ian thought it was about time that Part IIB and MPhil ACE students have the chance to receive a systematic account of this increasingly important area in Chemical Engineering. Over 1000 papers were published in Chemical Engineering journals on the topic of interfaces in 2016 and many many more are published each year across all scientific disciplines.

The course content was drawn from a variety of sources, including some materials were taught in the NST IB Fluid Mechanics course in the days of the 'old Tripos' (Ian is that old…). The emphasis was on understanding how surface tension works and how it can be used in static and flowing systems — hence the oil spreading (nicely timed to coincide with the release of the Deepwater Horizon movie – thank you Hollywood), water striders, and legs of wine. This was followed by material on the origins of surface tension, interface energies and how these are affected by surface morphology (very trendy topic) and surfactants (very lucrative topic). There is only so much surface chemistry that can be covered before it all becomes empirical….

Initial student feedback, gauged by the number of mince pies consumed in the last lecture (to accompany the 'legs of wine' illustration) was promising. Ian has learned much about surface tension during the preparation of the module and knows where improvements need to be made for next time (if the powers that be allow it). The students — including a goodly number of MPhil ACEs — now know what many chemists don't, namely the difference between surface tension and surface energy.

[1] www.vinepair.com/wine-101/wine-legs

ABB Rig Presentation

Professor John Dennis (left) and Neil Blackhall from ABB (right) exchanging the official handshake

ABB, which is part of the Teaching Consortium of Companies, has gifted CEB an experimental rig. The official presentation of the rig took place on Friday 2 December 2016 in the new Teaching Laboratory in West Cambridge.

The rig will complement the Process Dynamics and Control release, taken by Part IIA students, in terms of practical and experimental aspects.[2]

The ABB Rig will be further covered in the next issue.

[2] www.ceb.cam.ac.uk/news/news-list/abb-rig

UK Fluids Network SIG10 launched by Professor Ian Wilson

The UK Fluids Network has announced its first set of Special Interest Groups (SIGs) which are intended to bring together UK groups in fluid mechanics and related sciences involved in tackling strategic topics in industry and nature. The UK Fluids Network is an EPSRC-funded network of academic and industrial research groups, focused on innovative developments and applications in Fluid Mechanics. SIG 10 is on 'Fluid Mechanics of Cleaning and Decontamination'. Professor Ian Wilson is this SIG's co-leader. The work of this group will be focused on improving the procedures and technology in the area of cleaning and decontamination operations. The SIG 10 Launch Meeting took place at CEB on 26 January 2017.

More information on www.ceb.cam.ac.uk/news/news-list/new-sig

Taking Control of flowing disordered Materials

Alumnus Christopher Ness, Maudslay-Butler Research Fellow, Pembroke College, Statistical Physics Group

A shear thickening suspension reversibly solidifies as a large stress is applied

Disordered materials such as colloids, foams and gels are ubiquitous in industry and are some classical examples of soft matter. Historically, the properties of such materials (they can be thermal; their constitutive elements can be viewed under confocal microscope) have allowed them to serve very effectively as models to reveal the fundamental physics of atomic systems. Looking forward, recent advances in particle synthesis and functionalization have meant that soft matter systems now hold great promise as designer materials of the future.

They present intriguing mechanical properties: their rheology can vary between that of a viscous liquid and that of an elastic solid, simply by changing the preparation procedure or the flow conditions. My research aims to use both simulations and experiments to link formulation to flowability, for a variety of soft matter systems. The results from such studies might help to establish design principles for future smart materials and processes.

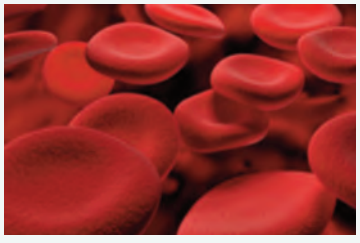
We focussed recently on shear thickening in dense suspensions and pastes, when the material almost solidifies (see inset) and the stress required to achieve a given flow rate dramatically increases. Such behavior can have dire consequences for processing. Our results provided strong evidence that particle-particle contacts are responsible, and that they are probably frictional in character [1]. This provides direct design guidelines: decrease the surface friction; decrease the extent of shear thickening. Moreover, we introduced an active flow control mechanism[2] that uses small vibrations to destroy these contacts, removing the shear thickening effect almost entirely. This technique can facilitate 3D-printing and extrusion of pastes at significantly higher solids contents without increasing energy input.

I am currently involved in several collaborations, looking at the rheological properties of vibrated suspensions, polymer glasses, immersed photoelastic granular disks, selectively attractive emulsions and highly confined colloids.

[1] C. Ness and J. Sun (2016) Shear thickening regimes of dense non-Brownian suspensions. Soft Matter 12(3), 914-924. doi:10.1039/C5SM02326B
[2] N. Lin, C. Ness, M. Cates, J. Sun and I. Cohen (2016) Tunable shear thickening in suspensions. Proceedings of the National Academy of Sciences 113(39), 10774-10778. doi:10.1073/pnas.160834811

Improving Biopreservation of RBCs using novel protective Agents

Noha Al-Otaibi, PhD student and Research Associate, Bioscience Engineering Group



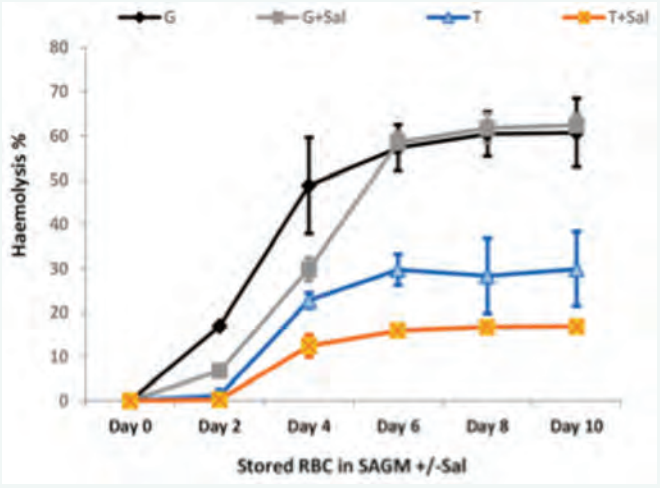
Red blood cells

Red Blood cells (RBCs) transfusion is an active practice in all health care centres around the world, to rescue lives and improve health.

Accessing safe blood at any time is a major issue for many patients, due to a sudden emergency or crisis that can dramatically raise the demand of blood. Unavailability of blood may lead to deaths or ill-health. Therefore, blood banks always depend on safe unpaid donors to donate blood to ensure a constant and reliable supply of safe blood to patients.

The donated blood is first screened then preserved until it is needed. The preservation method could be either by cold storage or cryopreservation. The cryopreservation is more powerful as it guarantees the longevity of preserving blood unites up to decades unlike the cold storage where the blood will be expired after 42 days. The limitation of cold storage makes it no longer suitable for transfusion. However, although cryopreservation is the preferred method for RBCs and many living cells, imposing an ultra-low temperature on living cells can cause irreversible cryo-damage to the cells due to the ice crystal formation from frozen water. Furthermore, the use of cryoprotective agents such as glycerol is known as a toxic material that can induce a certain level of damage to major cellular molecules such as proteins and lipids. Also, little is known about the stability factors and conditions of cryopreserved RBCs post-thawing and how that can be improved. These factors highlight the need to improve the biopreservation of the RBCs and living cells.

In our research, we aim to improve the biopreservation by looking at the molecular signatures associated with the cells quality prior and post freeze-thaw and using trehalose, the disaccharide as a safe alternative cryoprotective agent. During our attempt to improve the cryopreservation of RBCs via loading the cells with trehalose, we found a number of enzymes and pathways responsible for red blood cells stability before and after freeze thaw. The intracellular enzyme lactate dehydrogenase (LDH) is a biomarker used as an indication to the level of stress and struggle the living cells experience during freeze-thaw. This can be mitigated by boosting the activity of glutathione reductase (GR), the enzyme responsible for reducing glutathione and protecting cells against oxidative stress.



Post-thaw haemolysis rate of RBCs stored and refrigerated in either sodium-adenine-glucose and mannitol (SAGM) solution alone or in the presence of salidroside (SAGM+Sal).Survival rate was assessed for up to 10 days. Data are expressed as mean ±SD ($p < 0.05$)[1]
Glycerol (G), Salidroside (Sal), Trehalose (T), Sodium-adenine-glucose and mannitol (SAGM).

More excitingly, we screened many compounds that have a potential to improve the cryopreservation of RBCs. We found out that adding salidroside, the active component of rhodiola rosea, to the cryomedia and storage media, significantly improved the stability of RBCs. This component promoted the activity of the GR and reduced the level of the stress the cells experience during cryopreservation. In addition, it enhanced the stability of the RBCs post freeze-thaw. This was seen in cryopreserved RBCs, when adding salidroside to the storing media and incubating the cells for 10 days post-thawing, where there was less than 20% haemolysis of RBCs when compared to the RBCs cryopreserved and maintained in SAGM only. The unique protection activity of the novel compound (Sal), along with trehalose, opens a new avenue of translational research in the fields of blood cell, stem cell, infertility treatment and potentially human tissue cryopreservation.

[1] Alotaibi NAS, Slater NKH, Rahmoune H (2016) Salidroside as a Novel Protective Agent to Improve Red Blood Cell Cryopreservation. PLoS ONE 11(9): e0162748. doi:10.1371/journal.pone.0162748

The Pill(ar) of Liberation

Dr Ljiljana Fruk, BioNanotechnology Group

www.sciencephoto.com/media/295552/view

It is the new trend of global neo-conservatism, often not easily grasped considering all the technological and scientific advances we have witnessed, that made me think about one remarkable formulation that has changed society in so many obvious and subtle,ways: the discovery and the production of the oral contraceptive.

This is not only because this was a real scientific feat, made possible through an unconventional and innovative funding model, but also because of the huge sociological changes it initiated.

The research into oral contraceptives was driven by female activists, who wanted to see an improvement in the treatment of women and prevention of their premature deaths caused by botched pregnancy terminations and poor childbirth conditions. The most prominent among the activists were a nurse, Margaret Sanger, and science-educated Katherine McCormick, both drawn to the cause by their own personal tragedies and fully convinced that women deserved an easy-to-use and readily available contraceptive. Interestingly, although holding a degree in biology from MIT (or because of it), Katherine McCormick did not really believe in academia, and being very wealthy after the death of her husband, she decided to give a large sum of money to a small, foundation-led lab, headed by Gregory Pincus, to work through the challenge.

Pincus was a reproduction expert unjustly called "Dr Frankenstein" after his success with *in vitro* fertilisation of rabbits in 1934. Probablybecause of the bad press, he ended up in the small lab where he could quietly work on his scientific interests. He was the first to see the connection between the hormone progesterone, which plays an important role in maintaining the pregnancy, and contraception. Thanks to his involvement in various reproductive cycle studies, he knew that, together with estrogene, progesterone prevents women from conceiving for the second time while already pregnant. He was convinced that the best way to make an efficient and user friendly contraceptive pill was to focus on progesterone. Katherine McCormick believed him enough to fund his research and so history was written.

But alas, natural progesterone is hard to come by and very expensive when extracted from animals. Or, so it was until Russell Marker isolated diosgenin, a compound similar to progesterone, from the wild Mexican yams. He was interested in the popular practice by Mexican women for hundreds of years , who had been eating yams for contraception. This inspired him to look for an effective compound within the plant. He went further than just isolating diosgenin: in early 1940s he synthesised progesterone from raw diosgenin. However, although this made progesterone considerably cheaper, it did not make it more useful; upon intake, the hormone was destroyed by the digestive system, making oral contraceptive ineffective and unfeasible.

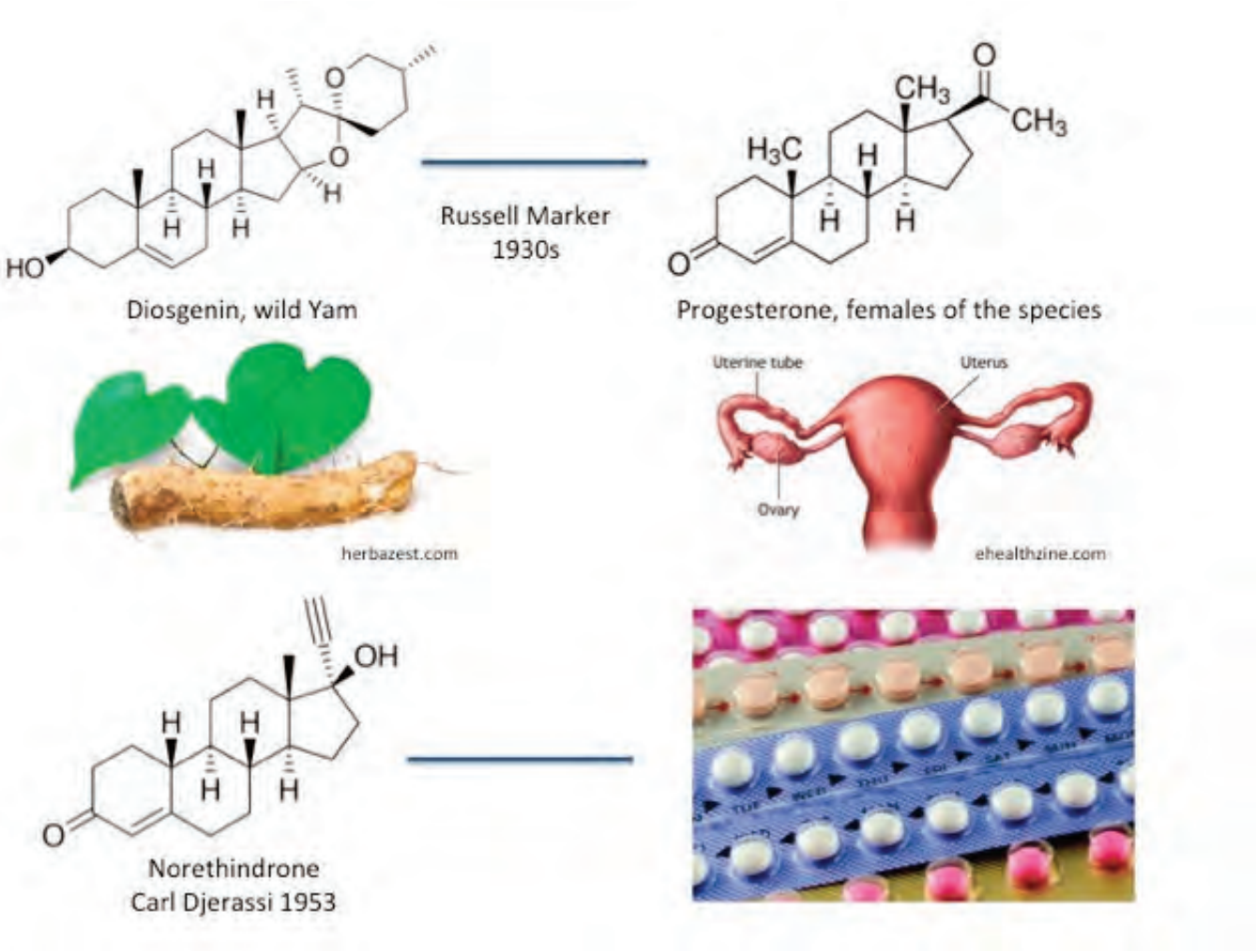
This was soon resolved by the synthesis of different progestins (synthetic progesterones), the first one being norethindrone produced by Carl Djerassi. Not only was it much cheaper, but it also remained intact after oral use and it was eight times more potent than the natural hormone.

The next step in the pill development was a larger clinical trial and things took an unethical turn here when high dosages of contraceptives were given to uninformed women in Puerto Rico. Ultimately, more controlled trials were conducted leading to the use of norethindorne as the main ingredient of the pill, sold under name of ENOVID in 1960.

I would not dare simplify the historical development afterwards and claim that the pill has kick-started the sexual revolution. It is more likely that both events

very closely interconnected and ran in parallel. However, it did bring about a huge change in the social and economic status of women. Ultimately, it has also improved women's health by reducing pregnancies and miscarriages, which was the initial intention of Margaret Sanger, when she set out to change the world through activism. In the past decades, it has also been confirmed that the pill has several non-contraceptive health benefits, including a decreased incidence in certain forms of cancer.

Synthesis and production of the pill is an example of the scientific and bio-tehnological achievements, which have definitely changed global societal trends and liberated women (and men!) from the conservative and dangerous constrains of narrow-minded views of religious movements and misinformed public and policy makers. Hopefully, the pill is not only going to be a reminder of the synergy between science and society-driven research, but it will continue to be the pillar of liberation: with unshakable foundation and fully accepted, not debated and questioned. There are certainly plenty more challenges to solve and issues to question! I can name at least 10 off the top of my head right now. And none of them is the pill.



© Dr Ljiljana Fruk Molecular structures of natural progesteron in Mexican yam and ovaries and the synthetic norethindrone in the pill

Towards an atomistic Theory of real Materials

Dr Alessio Zaccone, Head of the Statistical Physics Group

The research interests of the Statistical Physics Group at CEB, led by theorist Alessio Zaccone (currently a University Lecturer at CEB and formerly a W2 Professor of Physics at Technical University Munich), cover nearly all sectors of the physical sciences, from biophysics to metals, and from soft matter to mathematical physics. The group focuses on theoretical and computational methods and includes, to date, about 10 members. The mission of the group is to develop and apply new concepts and tools within theoretical physics to crack crucially unsolved problems in engineering and industrial applications. The activity of the group can be roughly divided into three major areas: soft condensed matter & complex fluids, hard condensed matter, and nonequilibrium statistical mechanics. The soft matter area is internally coordinated by Dr Chris Ness, who joined the group as a Research Associate last October. Problems currently being investigated in this area are the complex link between microstructure, mechanics and viscoelastic flow behavior of both colloidal and non-Brownian suspensions (see the separate article about Dr Ness' interests in *Research Highlights* section), the mechanical response of polymer glassy materials and the understanding of their interaction with light. In this latter area, an ongoing collaboration with CEB Professor Alexei Lapkin aims to provide a quantitative theoretical framework that allows one to deduce the molecular weight, the monomer conversion and (possibly) the particle size in emulsion polymerization processes, using any standard Raman spectrometer that can be fitted inside industrial reactors. The method is based on combining solid-state physics with polymer physics and the theory of light-matter interaction: by suitably coarse-graining the atomistic simulation of polymer chains packed in the amorphous state, Dr Zaccone and collaborators are able to numerically calculate the vibrational density of states (i.e. the distribution of normal modes) of amorphous polymers. This quantity, nickname by us "DOS", is highly sensitive to changes in molecular weight (i.e. chain length) and, therefore, to monomer conversion in polymerisation reactions, and also to the microstructure (i.e. chain packing) and size of the polymer particles. The theory of inelastic light scattering, also suitably modified and improved, then provides a one-on-one mapping between the DOS and the Raman spectrum that is measured experimentally in continuous mode. This powerful framework will provide the unprecedented opportunity to extract a wealth of highly non-trivial structural information at different length-scales in complex emulsion polymerisation processes, by just feeding the measured Raman spectra to the computational package being developed by the group. Dr Zaccone is particularly fond of this project as it exemplifies the extraordinary power of applying cutting-edge theoretical physics to engineering problems. PhD students Rico Milkus and Johannes Krausser and research student Jana Weber are currently working on this project. A related project focuses on the mechanical properties of polymer glasses, in a collaboration with the US Department of Defense, and is internally coordinated by Dr Vladimir Palyulin. Other important international collaborations on polymers are with the University of Amsterdam and with the Max-Planck Institute for Polymer Research in Mainz.

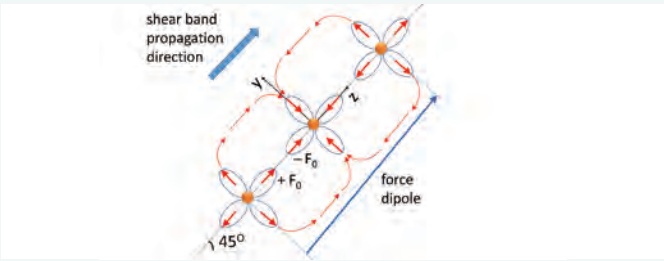


Figure 1: mechanism of shear-band formation by alignment of Eshelby quadrupolar distortions of the atomic-scale displacement field. Shear banding of an axially deformed sample typically occurs at 45 degrees with respect to the deformation axis, because the elastic energy of interaction of the quadrupolar structures is minimum along that direction. Each quadrupolar unit is an anti-vortex, from a topological point of view, which presupposes the existence of vortices nearby. Two quadrupoles aligned form a dipole of local forces along the 45 degrees direction. This model has been developed together with Prof. Gerhard Wilde and collaborators at the University of Muenster (Germany).

A continuing core interest of Dr Zaccone and his group in hard matter has been the understanding of the plasticity transition in amorphous materials under strain. The plasticity of crystals is by now well understood as being caused by the proliferation and motion ("gliding") of atomic-scale defects called dislocations. But what about glasses then? Clearly, in

glasses there are no defects because the atomic-scale structure of the material is homogeneously disordered. This problem is closely related to the glass transition problem, i.e. how a solid with a disordered structure turns into a liquid with the same "static" structure, and vice versa. In the case of glasses under deformation, a new paradigm, pioneered by Dr Zaccone among others, has emerged in recent years. This is the notion of nonaffine atomic-scale displacements, which are simply defined as all those atomic motions by which atoms "deviate" from the strain tensor of the applied deformation. Due to centro-symmetry being absent in glasses, these motions are triggered by local force imbalances that are, by definition, less crucial in in crystals possessing centro-symmetry. Upon increasing the deformation, these motions become self-organised and display both vortex and anti-vortex structures. A current effort in the group is to explore whether the appearance of these vortex and anti-vortex pairs could be the signature of an underlying topological phase transition, possibly of a similar kind to the one proposed by 2016 Physics Nobel laureates David Thouless and Michael Kosterlitz to explain crystal melting in 2D. This line of research is being developed in close collaboration with leading experimental groups in the US and Germany. Typical nonaffine anti-vortex structures called Eshelby quadrupoles are thought to align to minimise their elastic interaction field, as schematised in Fig.1, thus generating a shear band instability connected with plastic behaviour. Other problems currently being studied in hard matter by Dr Zaccone are the theory of elementary excitations (both fermionic and bosonic) in disordered solids, especially in metallic glasses, where plasmons and phonons are typically strongly affected by disorder.

And last but not least - statistical mechanics and its (many) applications:

A recent effort of the group has been to extend Arrhenius law to low energy barriers, or, which is the same, high thermal fluctuations. We all learned in school that the time-scale of chemical reactions is governed by the thermally-activated jump of the reactants over an energy barrier, and it is an exponentially increasing function of the ratio of energy barrier to thermal energy. Back in 1940 Physicist H.A. Kramers was the first to derive the Arrhenius law from first-principles in a deservedly famous paper. But what happens if the ratio of energy barrier to thermal energy is low, for example in the range between 2 and all the way down to zero? Dr Zaccone and PhD student Thomas Gray, in collaboration with Post-doctoral Associate Dr Masoud Abkenar, have recently provided an answer to this question. They found that Arrhenius law becomes strongly violated as the energy barrier to thermal energy ratio falls below 3, and using Arrhenius law leads to errors as a large as a factor of 20. An analytical theory has been developed, and verified by numerical simulations, which can be successfully applied to extract the internal energy of folding in proteins in their native state that are mechanically unfolded using AFM and optical tweezers (Fig. 2). However, the theory is much more general: PartIIB students Sanil Roy and Sai Eccles are now applying the theory to calculate how the fission rate of highly excited atomic nuclei deviates from exponential behaviour, where now the relevant energy barrier is the binding energy of the nucleus along the quadrupolar deformation coordinate.

Finally, a long-standing interest of Dr Zaccone in biophysics has been the modelling of amyloid aggregation processes, an important topic for neurodegenerative diseases. The modelling effort continues in close collaboration with Professor Clemens Kaminski and Dr Gabi Kaminski-Schierle in CEB, and with Professors Tuomas Knowles and Daan Frenkel in the Chemistry Department ain Cambridge, with a few papers on this topic =having been jointly published in 2016.

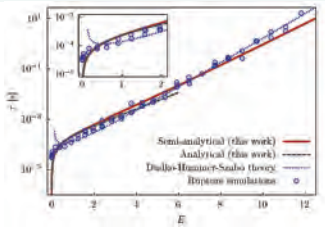


Figure 2: theoretical calculations of the lifetime of a protein folded bound-state upon applying a linear force with an AFM cantilever, as a function of the ratio (E) between unfolding energy barrier and thermal energy. When E<2 a famous theory by Dudko, Hummer and Szabo (published in Phys. Rev. Lett. 2006) which was based on Kramers' theory of thermally-activated reactions, produces an essentially unphysical outcome: the lifetime increases upon increasing the temperature. A new theory proposed by Thomas Gray, Masoud Abkenar and Alessio Zaccone which is based on a new amendment of Kramers theory at low energy barriers, gives instead the right physical behavior, in agreement with simulations data.

The Tales of a MicroCapillary Film

Dr Nuno M. Reis, Reader in Bioengineering and Biomedical Innovation, University of Bath

CEB at Cambridge is renowned not only for its world class research, but also its tradition in making ground–breaking discoveries and inventions. A good number of *CEB Focus* newsletter readers will remember for example the invention of Plastic MicroCapillary Films (MCFs) by Professor Malcolm Mackley and Dr Bart Hallmark in the early 2000s. MCFs can be described as a plastic tape containing a parallel array of hollow microcapillaries running along the tape. Malcolm's Polymer Fluids Group was very active exploring potential applications for this 'really cool' microengineered material, which was initially invented without any specific technological application in mind, and early application ideas included 'clever' heat transfer and microdroplet formation designs. I joined the 'MCF team' back in 2008 after securing a Marie Curie Intra-European Fellowship to explore the MCF as a chromatographic adsorbent for rapid separation of proteins, based on the high surface-to-area-volume ratio of MCF microchannels. In those days, people were genuinely enthusiastic about the flexibility and low-cost of the MCF material, however, these two features alone were not sufficient to create a novel application breakthrough. In some aspects MCFs were no different from individual plastic capillaries tubes that are also cheap and can be sourced from traditional lab suppliers. Some of Malcolm's students wrapped several meters of material to produce a compact 'disc' microreactor to perform continuous flow chemistry experiments, however, initial momentum died away with high pressure drops and poor connectivity to fluid handling equipment, such as HPLC pumps, causing difficulties where, in the prototype days, connections relied on Blu-Tack, Araldite, tools borrowed from the workshops, and a good dose of perseverance.

Malcolm remained active publicising his invention and searching for the 'killer application' even beyond his retirement in later 2011. This coincided with my move to Loughborough, where I secured a Lectureship, also in 2011. In my experience, creating interest to MCFs among industry and academic groups was challenging as at the time the amount of operations that could be done with the MCF was limited to one: flowing liquids through the parallel array of channels. There was no possibility of combining or splitting streams, or creating a design that looked 'cool' to the eyes of clever scientists. Also, melt-extrusion (the technique used to manufacture the MCFs) was regarded as not that exciting – after all, anyone can extrude spaghetti at home, so why bother with MCFs? Samples of MCF remained on the desks and drawers of many academics for a number of years, as many regarded MCFs as a concept that was 'too simple'.

Figure 1. MCF-based instrument developed for rapid, point-of-care measurement of cardiac biomarkers.

Back in 2011, I started my own research group at Loughborough (now in the process of relocating to Bath), and established an application of MCFs to clinical bio-diagnostics, in close collaboration with another Cambridge alumnus, Dr Al Edwards, based at Reading. Al and I managed to convince Cambridge Enterprise back in 2009 to file a patent application (recently granted in USA and Europe), based on some successful 'after hours' experiments. We both had very young babies at the time, and perhaps felt the need of 'sharing the love' and doing something exciting and 'out of the blue' in the Bioscience Engineering (CUBE) labs at CEB. We then actively engaged with Cambridge Enterprise in developing a commercial plan, and quickly realised the MCF diagnostics concept was potentially disruptive and at that time, the diagnostics industry did not understand how to perform an immunoassay in a microcapillary, so back in 2012 we established Capillary Film Technology Ltd jointly with Lamina Dielectrics Ltd (the exclusive MCF license for manufacturing of MCF from fluoropolymers). Since then, CFT has exhibited in Medica (the largest trade show for medical technologies) in November 2013 in Dusseldorf, Germany and invested over £1.5M in the

MCF diagnostics concept, and we grew the IP portfolio (currently working on the 4th IP stack). This included a £1.1M development contract with SBRI Healthcare/Innovate UK in the period 2014-2016 for developing a point-of-care test for a rapid "rule out" of heart attacks in patients reporting to A&E with symptoms of chest pain (Figure 1). To my knowledge, this is the only 'microfluidic' technology so far in which NHS has invested. It is interesting to think that until late 2013, I never dared label MCF as a 'microfluidic' material, to avoid 'offending' the sophisticated 'Lab-on-a-chip' community with the 'simplicity' of the MCF devices.

Currently, CFT is on the verge of securing a multi-million investment with the hope of turning MCF diagnostics technology perhaps to the next Billion-dollar business in few years. How was that possible? Well, by exploiting the 'simplicity' of MCFs and looking at the full landscape of growing clinical diagnostics and microfluidic technologies markets. The business model has continuously evolved since the day CFT was established, adapting to unique aspects of manufacturing, development, sales and health economics of a very specific first product. The simplicity of that first product is intrinsically linked to the nature of the MCF material. Al and I have become accidental entrepreneurs, but we have both taken our new roles in CFT very seriously, at the same time, we pushed the science and technology to its limits. It is the combination of unique MCF features with unique selling points of that first product that hopefully will lead to the successful adoption of MCF technology. Surprisingly, MCF solves a massive problem in microfluidics which is the scale and cost of manufacturing. It is currently possible to manufacture over 10km of MCF per day with a single melt-extrusion line, which is enough to produce up to 1 million test strips by simply trimming the MCF reel into short (1-3cm in length) strips.

In my view, MCFs are on the path to become one of the 'coolest' innovations in microfluidics. After all, most of the current 'clever' operations of microfluidic chips do consist in flowing a sequence of reagents through straight microchannels. In that respect, the design of a 'microchip' cannot beat the simplicity of a short piece of MCF. To our advantage, experiments with MCF can be carried out without the need of a clean room and recently MCF work has made front cover of RSC's Lab-on-a-chip and other high-impact journals (Figure 2). Hundreds or thousands of 'microfluidic' MCF strips can be manufactured or used in a single day at very, very low cost. We have 'invented' the 'Lab in a briefcase', 'Lab in a stick' and 'Lab on a comb' and hopefully the family will keep expanding as we push harder on the technology development. Our team has made a good presence in microTAS2016 in Dublin in October 2016 presenting 7 conference papers, including miniaturisation of bacteria identification

Figure 2. Recent cover artworks featuring MCF technology.

and antibiotic susceptibility testing, so probably we are not too far from an exclusive MCF conference.

Application of MCF to point-of-care diagnostics has been enabled by one of the most surprising features of MCF, something noticed back in 2008 during some early experiments using a Leica confocal microscope at CEB: the excellent matching optical properties of fluoropolymer MCFs. The high signal-to-noise ratio obtained during the optical interrogation of MCFs (colourimetric and fluorescence) is key to the detection of pico to femtomolar concentration of protein biomarkers in human samples in a portable and affordable format. Also, analysis can be done from whole blood dispensing the need of sample preparation; this is likely to be a game changer, as sample preparation is perhaps one of the most complex steps to miniaturise. We have also demonstrated the ability of optically interrogating MCFs using smartphones,. This has featured in one of the BBC Click programmes on Personalised Medicine back in the summer 2016. The beta-prototype in Figure 1. uses components of a smartphone for optical interrogation of the MCF test strip in a disposable cartridge.

An initial 'Simple' MCF manufacturing invention has now been turned into a 'Sophisticated' bio-diagnostic product. Great inventions often do take time to make an impact and MCF bio-diagnostics technology is certainly no exception. It took us time to properly engineer the 'simplicity' of the MCF material, yet we could not have imagined a different path, even Albert Einstein once said: "Everything should be made as simple as possible, but not simpler".

See alumni Dr Reis and Dr Edwards' profiles on www.lboro.ac.uk/departments/chemical/about/people/archived/nunoreis and www.reading.ac.uk/pharmacy/about/staff/a-d-edwards.aspx respectively

CEB "retired" Professor Mackley's work on MCFs on www.malcolmmackley.com/innovation/plastic-microcapillary-films and joint research published on MCFs on http://pubs.rsc.org/en/Content/ArticleLanding/2011/LC/C0LC00357C#!divAbstract

Horizon's Turbo JSP tagged HAP1 cell lines among the "Scientist" List of Top 10 Innovations

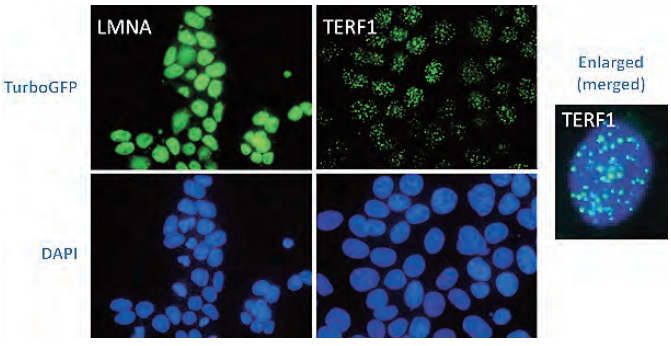
Biotechnology Alumnus Dr Darrin Disley

Horizon Discovery, a world leader in the application of gene editing technologies, has, for the fourth year in a row, had one of its portfolio products included in The Scientist's List of 'Top 10 Innovations' of the year.

The latest product to have been chosen by a panel of expert judges was Horizon's Turbo GFP tagged HAP1 Cell Lines, which enable researchers to study proteins at the endogenous level in live cell assays. The cells combine three leading technologies: CRISPR Cas9 gene editing; the HAP1 cell line; and Turbo GFP™, an early maturation fluorescence protein from Evrogen.

Dr Darrin M. Disley, CEO and CEB alumnus commented; *"We are delighted that cutting edge technology provided is being recognised at the international level. In combination with the companies previous award winning Knock-out, Knock-in and Reporter cell-lines Horizon now supplies an affordable suite of tools to help researchers study the deep functional biology of their genetic features of interest."*

See more information on www.horizondiscovery.com/cell-lines/x-man-reporter-cell-lines/turbo-gfp and The Scientist magazine article on www.the-scientist.com/?articles.view/articleNo/47537/title/Top-10-Innovations-2016



Turbo diagram showing the turbo GFP tagged cells

MedImmune - CEB Collaboration

MedImmune, a Member of the AstraZeneca Group

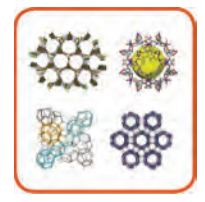
MedImmune, the global biologics research and development arm of AstraZeneca and the Department have been awarded a Collaborative Training Partnership (CTP) from the Biotechnology and Biological Sciences Research Council (BBSRC). The partnership includes the universities of Leeds, Manchester and Sheffield, structured as 12 PhD studentships.

Funded by the Government's Department for Business, Energy and Industrial Strategy, the BBSRC is the lead funding agency for academic research and training in the biosciences at universities and institutes throughout the UK. The CTP studentships are designed to invest in the training of the next generation of scientists for the wider bio-economy and research base, providing access to facilities and expertise unavailable in an academic setting alone. Working collaboratively, MedImmune and its academic partners will co-locate the four-year-long studentships at their respective facilities — including MedImmune's Cambridge site — to advance discovery and development in Industrial Biotechnology and Bioenergy.

Professor John Dennis, Head of Department, said; *"The Collaborative Training Partnership represents a tremendous opportunity to strengthen established — and develop new — research collaborations between the University and MedImmune scientists. At the same time, we want to ensure that the programme will furnish the next generation of researchers with the wide ranging technical and professional skills that will be required to effectively tackle challenges confronting the biopharmaceutical and related industries. This investment, coupled with the international-class facilities and research environment provided at Cambridge, and shared with our consortium partners, provides a means of accomplishing these objectives."*

The first round of studentships will commence in October 2017 and two additional intakes will follow in October 2018 and 2019.

New Spin-out Tarsis Technology Ltd



Tarsis Technology Limited is a new spin-out company that will develop and commercialise the technology created by Dr David Fairen-Jimenez and his research team. Dr David Fairen-Jimenez is a Royal Society University Research Fellow at the Department and leads the Adsorption & Advanced Materials Group. Tarsis is the third spin-out from the Group. The technology allows slower and more controlled delivery of drugs using metal organic frameworks (MOFs). The pharmaceutical industry has demonstrated early interest in the technology.

Frontier IP, which specialises in the commercialisation of intellectual property, has received a 20% stake in Tarsis Technology Limited. The role of Frontier IP will be to provide commercialisation services and in-depth pharmaceutical industry expertise. Dr Campbell Wilson, a non-Executive Director of Frontier IP, has been appointed as a non-executive Director of Tarsis. Dr Wilson is currently a member (and past Chairman) of the Board of the UK Pharmaceutical Licensing Group and has worked in the pharmaceutical industry for over 35 years.

Dr Campbell Wilson, non-Executive Director of Frontier IP and non-Executive Director of Tarsis, said: *"We are looking forward to working with Dr Fairen-Jimenez on this promising opportunity. Frontier IP brings experience in commercialising IP and relationships with key players in relevant markets. Dr Fairen-Jimenez's technology approach combined with our support and network in the pharmaceutical space can help accelerate the commercialisation for this exciting technology."*

Dr David Fairen-Jimenez, Chief Executive of Tarsis, said: *"This is a great opportunity to see state-of-the-art materials we prepare in our labs move into the market. The synergy between Frontier IP and their experience in new ventures and in the pharmaceutical industry combined with our leading work in advanced materials for drug delivery will give a strong commercial dimension to this project."*

Medals & Awards

CEB congratulates Professor Sir Fraser Stoddart on his Nobel Prize in Chemistry

Professor Sir Fraser Stoddart from Northwestern University has been awarded the 2016 Nobel Prize in Chemistry along with Jean-Pierre Sauvage and Bernard L. Feringa for the design and development of the world's smallest machines. Professor Stoddart's recent research explores organization of molecular switches interlocked within porous crystalline materials such that the electronic state of the switches can be altered by the application of an electrochemical potential. This strategy is useful to integrate dynamic, stimulus-responsive, mechanically interlocked molecules with the robustness of porous solids.

CEB's Dr David Fairen-Jimenez, Lead of Adsorption and Advanced Materials Laboratory (AAML), has been collaborating with Professor Stoddart on the use of molecular simulations to understand the arrangement of molecular switches inside the pores of metal-organic frameworks (MOFs)[1].

Their collaboration also involves work in the area of purification of valuable chemical feedstocks using efficient adsorption-based separation technologies[2].

More information on www.ceb.cam.ac.uk/news/news-list/ceb-congratulates-fraser-stoddart-nobel-prize

[1]www.pnas.org/content/112/36/11161.full
[2]www.pubs.acs.org/doi/abs/10.1021/ja511878b.

Dr Jacqui Cole awarded ALC Facility to develop Solar-Powered Windows

Dr Jacqui Cole, leader of the Molecular Engineering Group, has been awarded a Tier 1 Argonnne Leadership Computing Facility (ALCF) Data Science Program (ADSP) for her work on Data-Driven Molecular Engineering of Solar-Powered Windows. The ALCF is one half of the US Department of Energy's (DOE) Leadership Computing Facility, which deploys two diverse high-performance computer architectures. ALCF projects cover many disciplines, ranging from Chemistry and Biology to Physics and Materials Science. ADSP tackles "big data" science problems that require the scale and performance of leadership computing resources. The goal of the program is to help explore and improve various computational methods that will enable data-driven discoveries across all scientific disciplines. Dr Cole and her team will develop dye molecules that absorb light efficiently, which can be then used in the next-generation technology of solar-powered windows. These are deemed power buildings, in an entirely energy-sustainable fashion in the near future.

More information on www.ceb.cam.ac.uk/news/news-list/solar-powered-windows

NSERC Scholarship Award to Dr Eaves

Natural Sciences and Engineering Research Council of Canada (NSERC) Post-doctoral Fellowship (PDF) has been awarded to Dr Nick Eaves. The award is given to outstanding Canadian post-doctoral researchers to pursue a defined research program at Canadian and International Institutions. Dr Eaves plans to utilise the NSERC PDF to investigate particulate matter formation from combustion engines and flames utilising detailed ODE-based and stochastic-based models. He will be working under Professor Markus Kraft in the Computational Modelling (CoMo) group.

Fellowships

College Fellowships for Dr D'Agostino and Dr Torrente

Congratulations to Dr Carmine D'Agostino and Dr Laura Torrente on being elected as Senior Research Fellow at Wolfson College and Fellow at St. John's College, respectively.

Dr Carmine was appointed Lecturer in 2013. He was a Junior Research Fellow at Wolfson for three years and now the College has given him "Extraordinary Fellowship" based on his significant contribution to the College. His research interests lie in catalysis and reaction engineering, with a particular focus on the investigation of molecular diffusion, dynamics and

adsorption of liquids within porous catalysts. Dr Torrente joined the Department as a Lecturer in 2015. She is the Head of Process Integration group, which focuses on the integration of processes and development of novel catalytic routes for sustainable technologies.

Source: www.ceb.cam.ac.uk/news/news-list/fellowship-oct16 www.admin.cam.ac.uk/reporter/2016-17/weekly/6449/section11.shtml

Industry Grants

£1.5m for Dr Torrente to reduce Industrial Energy Demand in UK

Dr Torrente has been appointed as the co-investigator of a 4-year Engineering and Physical Sciences Research Council (EPSRC) funded multidisciplinary project *"Energy-Use Minimisation via High Performance Heat-Power-Cooling Conversion and Integration: A Holistic Molecules to Technologies to Systems Approach."* The project aims at minimising primary-energy usage in UK industry. It involves the use of next-generation technological solutions, identifying the challenges, and assessing the opportunities and benefits resulting from their optimal implementation. The project will eventually lead to breakthrough energy-utilisation solutions, transform industrial practices, lead to reductions in energy-input to industrial processes. It will also look into emissions reduction and increasing resilience to uncertainty in primary-energy supply. It will lead to transformative improvements in materials and equipment design and process operation, with substantial efficiency gains as well as give UK a significant lead in the design, development, manufacture, installation, operation and knowhow of these technologies and their implementation.

More information on www.ceb.cam.ac.uk/news/news-list/energy-aug16

Twin-Win for Dr David Fairen-Jimenez

Dr David Fairen-Jimenez has been awarded €1.9 M ERC grant and his spin-out Immaterial Labs Ltd have been granted £300k after winning the Energy Catalyst Award. European Research Council (ERC) has awarded a Consolidator Grant to Dr Fairen-Jimenez for his work on "A new generation of nano-capsules for drug delivery and bioimaging in cancer diagnosis and therapy." ERC Consolidator Grants are designed to back up researchers who want to establish their research teams and continue developing a successful career in Europe. The scheme also strengthens independent and excellent new individual research teams recently created. Dr Fairen-Jimenez's work will focus on nano-capsules with enhanced metal-organic frameworks (MOFs) to protect and deliver therapeutic agents, including macromolecules such as small peptides and RNA.[1]

Dr Fairen-Jimenez is the Chief Security Officer (CSO) of Immaterial Labs Ltd, a University of Cambridge spin-out company, which has developed a patent-protected method for shaping MOFs into pellets, called 'monoliths'. Their monoliths have four-times the density of the equivalent powdered MOF, and four-times the volumetric storage capacity, as well as enhanced mechanical stability. A one-year grant starting from April 2017 has been awarded for his project entitled *'Monolithic Metal-Organic Framework Materials for exceptional Natural Gas Uptake'.* This is a collaboration between Immaterial Labs and the Centre for Process Innovation (CPI), a Government-backed High Value Manufacturing Catapult and will be used to address the issue of manufacturing monolithic MOFs on a large scale. The award was provided by the Energy Catalyst, established in 2013 by Innovate UK, the Engineering and Physical Sciences Research Council (EPSRC) and the Department of Energy and Climate Change (DECC), with an aim to accelerate innovation by providing investment and support at the time, in the way and at the scale innovators need it.[2]

[1] www.ceb.cam.ac.uk/news/news-list/erc-grant-for-david-fairen-jimenez
[2] www.ceb.cam.ac.uk/news/news-list/immaterial-dec2016

From Engineering to Oil Research in Investment Banking – a Path more predictable than Oil Prices!

Dr Abhishek Deshpande, CENG, Chartered Energy Engineer, Head of Energy Research at Natixis

Working at an Investment Bank (IB), my career path was not as traditional as it is usually for Chemical Engineering graduates and definitely not as glamourous as shown in the movies. On the contrary, after the financial crisis of 2008-09, investment banking was anything but glamourous. However, I still decided to join the industry because of the dynamic nature of my current job and competitiveness that is still very much a strong element of IB.

After I graduated in Chemical Engineering from the Institute of Chemical Technology in Mumbai (formerly known as UDCT), I decided to pursue a doctorate in the same engineering discipline from Cambridge. I matriculated in 2005 from Trinity Hall and was fortunate to be supervised by Professor Nigel Slater. I remember vividly on my first day in Cambridge in Nigel's office, Nigel told me" Abhishek you are starting your PhD on 4 October 2005 and I want you to be out by 3 October 2008". That was brilliant because it made me consider PhD almost like a course with a 3 year timeline. My PhD dissertation was on microfluidics and its application in biotechnology.

It was during my time at Cambridge, I had the opportunity to attend some cross-department seminars on finance and trading by investment banks. However, since it was the peak of financial crisis in 2009, it was not until the summer of 2011 when I started working as an Oil Analyst at a French IB in London. It was an opportunity that combined two key things I was looking for: 1) My passion for energy markets 2) Quantitative and rigorous analysis. And because I was passionate about oil markets, I knew I would enjoy it on a daily basis. Rightly so, I managed to learn the ropes of energy trading and finance in a short time frame.

CV

A passionate energy markets analyst. Written over 300 reports on energy markets in internal and external publications.

2011-Present: Chief Energy Market Analyst and Strategist - Natixis SA www.natixis.com

2009-11: Project Manager/Consultant Analyst - Oakland Innovation Ltd

2005-09: PhD, Chemical Engineering - Trinity Hall, Cambridge

2004: Process Engineer - Indian Oil Corporation Ltd

2001-05: BChemEng, Chemical Engineering - UDCT Mumbai

Today, I head the energy research team at Natixis. I manage a small team of two analysts which is expanding fast. My day to day role involves carrying out in-depth fundamental research on oil, gas and renewables (most O&G focused), analysing investment flows and bottom-up fundamental analysis of energy corporates. Just like during a PhD, we have published internal and external papers in international journals and magazines. Recently we were awarded the best commodities research house of the year by Energy Risk and Energy Economist of the Year Award from Petroleum Economist, recognising our research at an international level.

Although my educational background is slightly detached from what I am currently doing, what I hope to emphasise through my short note in the Alumni corner is that my PhD from Cambridge has most definitely helped me reach where I am today in a short time span and most importantly the route to success that I have learnt so far, is having a clear goal, hard work, perseverance and of course a "bit of luck". Good luck!

See Abhi's recent achievement on www.petroleum-economist.com/articles/corporate/pe-award-winners/2016/executive-of-the-year-2016-abhishek-deshpande-natixis

Event Reviews

CEB Career Panel returns

The corporate reps paid CEB their annual visit to tell undergraduates about their day to day jobs, advise them on career matters of interest and inform them about vacancies available in their companies at the CEB Careers Panel event on 8 November. They also discussed about work-life balance, desired organisational values and the types of corporate support available. Stephen Watson, Arthur D Little, pointed out that following a serious safety incident with loss of life at a chemical plant he was working in on his third week into a new job in Melbourne, it made him look into the fundamentals of process and consider a career in safety. Graduate Myrice Palor, having been on a GSK Graduate programme, noted; 'being in a job where I can make a difference drives me'. The students were grateful for being able to hear first-hand about the highlight career moments of the Chemical Engineers on the panel and for the valuable advice given by the experts. Ray Fan, CUCES Careers Rep and Panel Moderator, commented; "The CEB Careers Panel 2016 was an insightful and interesting panel that has improved vastly over the years. I really enjoyed the diversity of experience and the breadth of advice offered by the panellists! The greatest "takeaways" I had from the session was to go for a company that "walks the talk" in terms of company values, as well as to bravely make a choice. The phrase, "I'm the master of my ship…" comes into mind. An inspiring and memorable afternoon with an interesting group of speakers indeed!'

Rachel Cooke, SABMiller, commented; *'Life is all about the choices that you make. My choices have taken me on a particular journey. The biggest challenge in life is working with people.'* Amanda Talhat, PepsiCo, added *'for me being part of a team in a company that lived its values was important, I wanted to find a company that was honest.'* PeterHarding, University of Cambridge Careers Office praised the advice given by graduates and commented; *'Cambridge Chemical Engineering degree has one of the highest employment rates of any degrees, because of the very impressive record of the curriculum and the way engineers work.'*

It is the first time Gradcracker, UK's career web for STEM students, gets involved in the event and we are delighted with the value they have brought to the event. Gradcracker rep Sophie Ibbotson inspired students to stay in STEM jobs and pointed out that *'Gradcracker offers CEB graduate schemes with a wide variety of companies in a wide range of sectors. It's a platform for companies to recruit high quality engineers and to help students finds suitable jobs in great companies'.*

Event organiser Elena Gonzalez, commented; *'Our students enjoyed hearing about the experiences and career highlights of our graduates working in very varied roles across a whole range of industries. The event also provided our students with some recruitment opportunities. CEB would like to thank all corporate reps for their continued support and would be delighted to get more relevant companies involved in this event in the future.'*

CEB would like to thank all the industry reps who have contributed to the CEB Careers Panel. For graduates working in industry wishing to get involved and represent their company at similar events in the future please contact Elena on eg314@cam.ac.uk

First Xmas in CEB new Building

The annual highlight event was the first Xmas party to take place in the new building, after Phase 1 of the move was successfully completed at the start of Michaelmas term last October.

Following the Staff Away Day, HoD Professor John Dennis welcomed the crowd and gave colleagues and students his best wishes for the festive season. Department staff and graduate students congregated in the Atrium to have some festive fun. Department members were treated to first class entertainment with hugely talented piano player Erina Hayama. She was the first professional to test the departmental piano, the latest addition to the new building Atrium, which arrived on site just in time for eth celebrations beginnings of December. Erina is a concert pianist from Nara, Japan and with some delightful pieces she kick of the evening party in style.

Pianist Erina Hayama in all her grandeur

After Erina's performance, Professor Dennis commented; *'I've been to many parties but this is the best entertainment I've ever seen in one of this type of events'.* He also handed Erina a piece of department art as a token of thanks for her amazing performance. The mini piano concert was followed by a gorgeous buffet courtesy of outside caterers Flair, who provided a nice splash of xmas food for all attendees. Colleagues and students clubbed together for good times and festive cheer. There we are also games and background music played, from Xmas carols to a 70s hit extravaganza. Some staff dressed up in festive attire and took part in the "Secret Santa" and "Who's that Baby" games, whilst others mingled, laughed and caught up over some celebratory food and drink.

The piano entertainment was extremely enjoyed by all, and coupled with merry colleagues, the party was a success overall. Throughout the evening, Elena went round taking photos of department members and those who dared being snapped with the festive photo frame, leaving great memories of CEB first xmas party in its new building in West Cambridge.

Thanks to all department members who organised and/or took part in the celebrations. Happy 2017 to everyone!

Upcoming Events

'CUCES Chemical Engineering Annual Dinner 2017',
Thursday 2 March 2017 at the Royal Cambridge Hotel

CEB Lunchtime Career Talks
Friday 10 March 2017

Stephen Capsaskis, MEng, PhD, Principal, 7L Capital Partners on "Venture Capital - Supporting Technological Innovation".

Commercialisation of an innovative process or product developed in a University or corporate lab can be rewarding both for the researcher doing the work and for his/her employer but someone has to judge whether it is worth commercialising and to back this with hard cash. Venture Capital funds do precisely that and require people with expertise in the technologies in which they invest.

Friday 12 May 2017
Dr Malcolm Wilkinson, Kirkstall Ltd Managing Director, *"Start-up Companies can be bad for your Health but good for Animals!"*

CEB at Cambridge Science Festival
The Science Festival provides the public with opportunities to explore and discuss issues of scientific interest and concern and to raise aspirations by encouraging young people to consider a career in science, technology, engineering or mathematics.

CEB will be contributing to the Festival again this year by hosting a molecule exhibition on site and running a science booth to engage the public with their research:

CEB Exhibition "Molecules that Rocked the World"
Monday 13 March to Friday 24 March (11am to 5pm)
These 25 molecules have changed our life, culture and social trends. Discover more about their structures, history, properties, applications and significance using a stereoscopic 3D display.

Organiser: Dr Ljiljana Fruk (lf389@cam.ac.uk)
Where: Department of Chemical Engineering and Biotechnology, New Museums Site, Downing Street, CB2 3RA (LT2)

CEB Science Festival Booth
Saturday 18 March (10am – 4pm)
CEB will be running an interactive and fun stall for parents and children and gifting participants with the CEB Science Colouring Book showing molecules and their key part in our innovative applications.

The festival welcomes visitors to hundreds of events and receives extensive national and local media coverage. Over 170 event coordinators organise talks, interactive demonstrations, hands-on activities, film showings and debates. See the programme on www.sciencefestival.cam.ac.uk/looking-forward-great-14-days

CEB Women amongst BioBeat 50 Movers & Shakers

Miranda Weston-Smith founded BioBeat in 2012 in partnership with Cambridge Judge Business School and Innovation Forum. BioBeat provides a collaborative innovation platform for bioentrepreneurs and leaders. BioBeat focuses on honouring successful women in biobusiness, who have made breakthrough in biotechnology for a more healthy and prosperous world.

The annual BioBeat16 conference took place on Wednesday 16 November at St Catherine's College, where the 50 Movers and Shakers in BioBusiness report was also released. The report nationally acknowledges women, who are actively involved in the future of healthcare and inspiring the next generation of Life Science leaders. The feature includes 24 Rising Stars alongside more senior colleagues involved in companies, research, hospitals, finance and advisory roles.[1,2,3]

The Rising stars include Theresea Maier, a second year PhD student in the BioScience Engineering Group, and Ipshita Madal, an alumna of CEB.

Professor Sabine Bahn has been mentioned again in BioBeat after also being listed back in 2014.

Theresa Maier in Rwanda

My passion for engineering evolved at the age of 19 in Rwanda, Central Africa. As a scholar of the German Federal Ministry for Economic Cooperation and Development, I lived for a year in an orphanage with over 130 orphans, while additionally working as a medical device intern at a children's medical unit of a Rwandan district hospital. Experiencing a life without running water and electricity, basic medical care and limited food, I learnt how engineering can change people's lives for the better, improve living conditions and even save lives. Ever since, I am passionate about using engineering to develop sustainable solutions to address global challenges, with a particular focus on medical applications. As an undergraduate, I have worked four years as a project leader for the 'Engineers Without Borders' and by building a solar energy system in my old Rwandan home, I was able to express my gratitude to the orphanage and the people who inspired me to pursue a career as an engineer.

CEB is a fantastic environment to follow my pursuit; as a PhD Candidate and WD Armstrong Scholar at both the Department of Chemical Engineering and Biotechnology (School of Technology), and the Department of Paediatrics (School of Clinical Medicine), I am working at the intersection of medicine and engineering, developing a novel drug delivery system for new-borns. As the low-cost device is designed to be used during breastfeeding, it is particularly applicable for low-resource settings where potable water is not readily available. The device also has the potential to serve new-borns in developed countries requiring continuous doses of medicine/nutrients, for example premature babies. I have been very premature myself, and thus, I am extremely grateful to be able to contribute towards a medical technology with the potential to improve treatment of premature babies just like me.

In order to reach infants in need globally, I am also working to commercialise my PhD research; I spun out the for-profit JustMilk Limited from the JustMilk charity in November 2015. Since its establishment, JustMilk Limited was fortunate to win many awards, amongst others the national McKinsey Venture Academy, as well as HRH the Duke of York's Pitch@Palace 5.0 competition. I am deeply honoured to be additionally recognised as one of the 50 Movers and Shakers in BioBusiness. I hope to serve as an encouragement for other CEB students at the beginning of their career, illustrating that the impact one can have is not determined by one's gender, age or experience, but only by one's passion and commitment to make a difference!

[1] www.globalbiotechrevolution.com/2016/11/30/biobeat-2016/
[2] www.mws-consulting.co.uk/biobeat/
[3] www.mws-consulting.co.uk/wordpress/wp-content/uploads/2015/02/50-Movers-and-Shakers-in-BioBusiness-2016-final.pdf

Meet Sabina Bryant

CEB Focus Team met up with Sabina Bryant in the New Year. She is the new Administrative Assistant, who joined CEB on 9 January. She will also be involved in manning Reception, once the whole Administration moves to the new building. Although she has been busy with inductions and getting to grip with tasks across different building locations, Chief Editor Elena Gonzalez managed to catch up with her over a quick coffee and had a chance to talk about her background, passions and motivations and first week at CEB.

- **Tell us a bit about your past and your background.**

I come from Michigan and lived in Hiroshima, Japan for 3½ years before moving to England in 1994. I taught TEFL, where I, also, met my British husband, who originally grew up in Cambridge.

- **What appealed to you about working at the University of Cambridge CEB?**

I like working for the University and in the Sciences.

- **Please tell us what your role involves.**

At the moment, it is a completely new role for the Department. I will be helping with HR and supporting colleagues as well as being on Reception. I will be working closely with Cara Bootman and Michaela McNeill. I am currently on Reception at TCR before the big move to the new building.

- **How has your first week been? Give us your first impressions.**

Everyone has been lovely and very welcoming. I already feel part of the team.

- **What would you like to get out of your professional experience at CEB?**

I look forward to learning a lot and getting to know everyone. Every Department works differently, so there is a lot to learn.

- **What contribution are you hoping to make to the Department?**

I hope to become a valuable part of the Department.

Let's now move onto more light-hearted questions!

- **I'm aware that you are a busy bee and volunteer your time for a couple of causes.**

I do like to volunteer and knit in my spare time.

- **I'd like to know a bit about your character…..Which fictional character you feel most identified with and why?**

I could identify myself with Biene Meier. A German/Austrian fictional character. She was a little bee that was a free spirit as well or even Pippi Longstocking? The same with her as well.

- **Who was your hero when you were growing up?**

It's a bit embarrassing, but not surprising being American, Wonder Woman. She is a strong and empowering. Despite the costume, the UN recently voted for her as well as a good role model for women.

- **What was your favourite subject in School?**

I loved Biology and did sport. I was on the swimming team and tennis team.

- **Tell us about how you normally like spending your spare time, passions and hobbies.**

I like the Arts and take classes in silversmithing and knitting.

- **What's your guilty pleasure?**

Chocolate!

- **If you were to be put on a deserted island and you were given the chance to carry 3 precious items with you, what would those be?**

The whole works of Shakespeare, paper & pencil and a boat!

- **If you had a time machine which era would you like to travel to and why?**

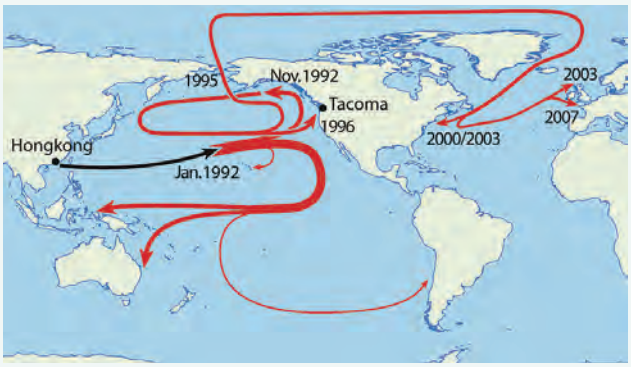
I like the 1950's style and fashion. My own house was built in 1958 and I like the features that I've managed to salvage.

- **Any personal goals in sight?**

To do my job well and to keep learning new things!

You can find Sabina at Tennis Court Road site. See her profile on www.ceb.cam.ac.uk/directory/sabina-bryant

The Rubber Duck Armada



World map tracking the 'friendly floaters' across the oceanic currents. Thickness of the line represents the number of bath toys.

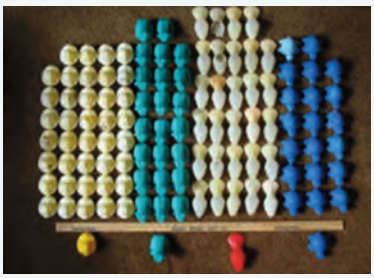
In 1992, a shipping crate containing 28,000 plastic yellow ducks, blue turtles, red bevers and green frogs was lost at sea when it fell overboard on its way from Hong Kong to the United States. No one at the time could have guessed that those same bath toys would still be floating the world's oceans nearly 20 years later. The plastic toys since then travelled halfway around the world, floating amongst others over the site where the Titanic sank. Some have washed up on the shores of Hawaii, Alaska, South America, Australia and the Pacific Northwest; others have been found frozen in Arctic ice. Still others have somehow made their way as far as Scotland and Newfoundland in the Atlantic. While the ducks are undoubtedly a loss to the bath-time fun of thousands of children, their adventures at sea have proved an invaluable aid to science.

The toys have helped researchers to chart the great ocean currents because when they are spotted bobbing on the waves they are much more likely to be reported to the authorities than the floats which scientists normally use. And because the toys are made of durable plastic and are sealed watertight, they have been able to survive years adrift at the mercy of the elements.

For the last 21 years, oceanographer Curtis Ebbesmeyer has been tracking the ducks, frogs and turtles from Sitka, where they first landed, all the way to Scotland and Maine. Having patiently recorded the date and location of each sighting, he has been able to learn an enormous amount about the ocean's conveyor belt. He correctly predicted what many thought was impossible - that thousands of them would end up washed into the Arctic ice near Alaska, and then move at a mile a day, frozen in the pack ice, around their very own North-West Passage to the Atlantic. It proved true years later and in 2003, the first "Friendly Floatees" were found, frozen and then thawed out, on the eastern seaboard of the U.S. and Canada. They are so precious to science, that the firm that made them is offering a £50 bounty for finding one.

Ebbesmeyer says only 3% of findings are reported, the last sighting he is aware of was a frog in August of this year. Today, he believes there are only a few hundred left still at the mercy of the winds and surface currents. Once the tale of the tub toys is over, Ebbesmeyer says he still has plenty of other container spills to help him track the currents -- 34,000 hockey gloves and 5 million Lego pieces were dropped in the ocean 16 years ago, for example.

Perhaps the most famous Floatees are the some 2,000 of them that still circulate in the currents of the North Pacific Gyre — a vortex of currents which stretches between Japan, southeast Alaska, Kodiak and the Aleutian Islands that the rubber duck armada helped to identify. Ebbesmeyer says "we always knew that this gyre existed. But until the ducks came along, we didn't know how long it took to complete a circuit. It was like knowing that a planet is in the solar system but not being able to say how long it takes to orbit. Well, now we know exactly how long it takes, about three years."



Friendly floatees as new, with some that have washed ashore

Bleached by sun and seawater, the ducks faded to white, but the turtles and frogs have kept their original colours. In case you find one and want to ensure you have an original, they can still be identified by their supplier's mark 'The First Years'.

Sources:
www.dailymail.co.uk/news/article-464768/Thousands-rubber-ducks-land-British-shores-15-year-journey.html
www.mnn.com/earth-matters/wilderness-resources/stories/what-can-28000-rubber-duckies-lost-at-sea-teach-us-about

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