Chemical Engineering on the rise

Research news and highlights

• UNSW Chemical Engineering soars in world university rankings
• Empowering people by ensuring nutrient security
• Shape matters: Tailoring droplets for targeted delivery
• 2 Eureka Prize finalists from UNSW Chemical Engineering
• Greenhouse gas reduction in the Australian context

Image: Endoskeleton droplets get smart and in shape!
Welcome from Head of School, Professor Vicki Chen

The beginning of this year was marked with a visit from our new Vice-Chancellor, Professor Ian Jacobs (pictured), and the new Dean of Engineering, Professor Mark Hoffman to our School. It was a great opportunity to display the breadth and depth of the research within the School including hydrogen storage, membrane technology, bio- and pharmaceutical processing, photo-polymerisation, and food technology.

Recognition of our research strength is also reflected in our recent QS ranking placing us at 28th globally in chemical engineering and in the top 10 on the National Taiwan University rankings for chemical engineering based on publication metrics. In this newsletter, a number of our rising stars in research are featured as well as how research in the school is impacting on crucial global challenges such as energy, climate change, food, and water.

The “Performance Ranking of Scientific Papers for World Universities”, also known as the NTU ranking, is released on an annual basis. The university objectively evaluates the academic performance of research universities in terms of quality and quantity of scientific papers in six fields and 14 subject areas.

UNSW Chemical Engineering on top in latest world rankings

UNSW Chemical Engineering ranked #10 in the world

In the recent “Top 500” universities released by the National Taiwan University, UNSW Chemical Engineering is placed at top 10 in the world and retained its title as number one in Australia.

The “Performance Ranking of Scientific Papers for World Universities”, also known as the NTU ranking, is released on an annual basis. The university objectively evaluates the academic performance of research universities in terms of quality and quantity of scientific papers in six fields and 14 subject areas.

UNSW Chemical Engineering jumps to 28th position in the world

In a fantastic result this year, UNSW Engineering has significantly improved in the Quacquarelli Symonds (QS) rankings. Big gains by Chemical Engineering, which leapt forward by 18 places to position 28th in the world, saw UNSW Engineering improve its subject rankings overall, placing it in the coveted world’s top 40.

The QS world subject rankings are based on research citations and reputational surveys of over 126,000 academics and graduate employers worldwide.

UNSW Chemical Engineering ranked #1 in Chemical Engineering School in Australia in 2015 National Taiwan University Rankings

UNSW Chemical Engineering ranked #1 in Chemical Engineering School in Australia in 2015 Quacquarelli Symonds (QS) Rankings

FAST FACTS AWARDS

QS RANKED 28TH IN THE WORLD. UP 18 PLACES FROM 2014

46th in 2014

28th in 2015

TOP 10

Chemical Engineering School Worldwide* ^2015 Quacquarelli Symonds (QS) Rankings * 2015 National Taiwan University Rankings

Membrane technology

Hydrogen storage

SEE THE FULL LIST OF NTU UNIVERSITY RANKINGS FOR CHEMICAL ENGINEERING
Empowering people by ensuring nutrient security

UNSW Food Science & Nutrition researchers are tackling malnutrition in Papua New Guinea through food fortification.

800 million people suffer hunger with two-thirds from the Asia-Pacific region. The most recent national nutrition survey conducted in 2005 showed long-term malnutrition issues in Papua New Guinea (PNG), Australia’s closest neighbour (Food and Agriculture Organisation, 2014, PNG National Dept. of Health et al., 2005).

Anthropometric measures used to determine the severity of malnutrition have failed to improve over the past three decades. The latest data (captured through weight, height, BMI and waist to hip ratio measurements) indicate that 49.5% of children under five are short for their age, 27.9% are underweight for their age and 14.3% suffer from wasting (underweight for their height). In conjunction with malnutrition, PNG communities suffer from malarial and hookworm infections that deplete iron stores causing high rates of anaemia (PNG National Dept. of Health et al., 2005).

Malnutrition needs to be addressed to reduce chronic disease and improve quality of life for future generations. The World Health Organisation (WHO) recommends food fortification as a key strategy to address this problem.

To this end, one of the largest flour millers in PNG has called on the expertise of Associate Professor Jayashree Arcot from UNSW School of Chemical Engineering. This collaboration will work on the multi-micronutrient fortification of wheat flour and address part of the company’s social responsibility to produce food products that improve the nutrition of the most vulnerable people within these communities in PNG – women and children.

Jayashree has many years of experience in Nutrition and has worked on the fortification of wheat and rice with folate in Australia. At the beginning of her career she was passionate about vitamin research particularly folic acid. She trailblazed the development of appropriate chemical methods to analyse folic acid in foods, developing techniques for fortifying foods with folate and studying human bioavailability of added nutrients in foods using stable isotope techniques and ex-vivo cell culture techniques.

Working within the Food Science group at the School of Chemical Engineering she collaborated with a food technologist Dr. Janet Paterson to develop methods for efficient fortification of wheat and rice with folic acid.

Working under Jayashree on this project is Scott Markham, a PhD student. Scott focuses on micronutrient fortification of wheat flour and assessment of bioavailability.

“I believe Australia has a responsibility to help Papua New Guinea (PNG), its closest neighbour. Whilst insufficient focus is applied toward nutrition initiatives, investment in other areas of economic development will have far less impact than might otherwise be expected. My conviction is that nutrition is one of the key ‘pillars’ of human and economic development which has the power to lift a nation out of the cycle of poverty and dependency.” Scott Markham.

Wheat flour is a staple food in PNG and provides an ideal vehicle for mass fortification to improve the community’s nutrition. As part of the project Scott is working to evaluate fortified foods that are culturally appropriate in PNG that are designed for toddlers and children. In a pilot intervention study Scott aims to assess the efficacy in improving nutritional status over a 6-12 month period. He will also be exploring the idea of complementary foods (taro, yam and sweet potatoes) to improve nutritional status of women and children for the long term.

Micronutrients are currently added to rice and salt in PNG: Thiamin (vitamin B1), Niacin (vitamin B3) and Iron are added to rice, and salt is mandatorily fortified with Iodine.

Jayashree and Scott are investigating ways to fortify wheat flour with β-carotene, Thiamin, Riboflavin, Niacin, Folic Acid, Iron and Zinc for mass fortification. The micronutrients selected are targeted to assist with the local nutritional problems.
Scott is undertaking a number of ex-vivo bio-accessibility studies to understand the levels of micronutrients that can be added for maximum absorption under various local cooking methods. These studies assist in determining the right amount of micronutrients to be added to the wheat flour to provide optimal nutritional content of the product. It will also provide economic benefits when sourcing ingredients and manufacturing.

The bioaccessibility studies also involve:

- Supplementing wheat flour with nutrients, then assessing the products with Caco-2 cell culture. Blending studies to test adequate blending of the micronutrients into bulk milled wheat to ensure homogeneity of nutrients (to be equally distributed throughout the product) and assess their bioavailability.
- Assess the shelf-stability and shelf life, which is generally shorter in tropical regions due to high humidity.

Of course there are other challenges that exist to ensure the food products are consumed safely and the maximum nutritional benefits are received. Access to clean water to cook the food with and basic WASH (sanitation and hygiene) practices need to be met.

Also involved in the study is Dr. Lydia Yalambing, an academic at the University of Technology in Lae, PNG. Lydia is an alumna from UNSW Chemical Engineering where she completed her PhD in 2014 under the supervision of A/Prof. Jayashree Arcot. She is a recipient of the Prime Minister’s Pacific-Australia award for her PhD work related to biodiversity of nutrients in Aibika, a green leafy vegetable commonly consumed in PNG.

Subject to ethics approval the next step of the project will be to conduct a series of randomised control studies over 6-12 months involving direct intervention studies within malnourished communities in PNG.

Results of the study will provide evidence of benefits assessed through clinical assessments, anthropometric testing and biochemical indicators to assess nutritional improvements.

There are many countries that don’t have wheat fortification where wheat flour is a part of the staple diet. The potential for this initiative is huge as also proven for some nutrients in other parts of the world; this approach could be adopted in many other countries and is highly relevant to countries where food security and malnutrition is an issue.


Associate Professor Jayashree Arcot

Jayashree is an Associate Professor for Food Science and Technology at the School of Chemical Engineering, UNSW Australia.

Fields of research: Analytical Chemistry, Nutrition and Dietetics, Other Biological Sciences

Research Interests:

- Food composition
- Fortification of foods with micronutrients: technologies, bioavailability in humans
- Development of isotope dilution methods for the analysis of vitamins in foods using LC-MS techniques
- Bioactive compounds in foods and their activities in vitro and ex-vivo
- Micronutrient bioavailability in humans using stable isotopic studies; ex-vivo cell culture techniques
- Use of immunoassays and microbiological assays for analysis of vitamins in foods

Scott Markham

Since graduating with a Bachelor of Science in Food Science and Technology from UNSW in 2005, Scott Markham has spent the past 10 years working with a range of local and multinational companies in the Australian food manufacturing industry. He has been involved in design, development, and innovation projects behind some of the country’s best known and loved brands.

Having worked in this field and gained a broad understanding of food manufacturing, innovation, operations, safety, supply and distribution, he has decided to pair this knowledge with research targeting some of the enduring challenges in global food and nutrition security. His project focus is to address micronutrient malnutrition in Papua New Guinea through multiple micronutrient fortification of food, dietary diversification and a complementary nutrition intervention study.
Shape matters
Tailoring droplets for targeted delivery

A team from UNSW Chemical Engineering and the Woolcock Institute is revolutionising treatments into respiratory disease by rethinking shape.

Associate Professor Patrick Spicer (UNSW Chemical Engineering) and colleagues, Associate Professor Daniela Traini and Professor Paul Young (the Woolcock Institute of Medical Research) are developing a new approach to the treatment of respiratory diseases by developing ‘SmartDrops’. This new particle engineering technology can be used to create structured liquid microdroplets (Smart Drops) with custom shapes. By tailoring liquid characteristics, the team can produce non-spherical elongated drops of different aspect ratios and surface morphology of precisely engineered droplets deposited directly in the human lung. Using state-of-the-art particle characterisation tools, the team has already made significant advancements in the area of in vitro delivery and testing.

As current, conventional therapeutics rely on solid, spherical particle shapes, this research represents a possible paradigm shift in the way respiratory diseases are treated.

Current approaches focus on long-term steroid therapy using unstructured liquid aerosols. The application of shaped particles has been shown to be a powerful discriminant of whether the human immune system can remove foreign materials; this effect can be exploited using liquid droplets to further enhance delivery.

Physical benefits of shape are also known, including improved deposition and filtration. An improved understanding of shape effects could even possibly lead to understanding why some microorganisms are more adapted to infect and avoid immune responses.

In the initial stages of the project, the team will develop new formulations and microfluidic devices to make small volumes of drops with varying shapes and test their properties. The approach will then be expanded to larger volumes and target production by consumer-grade aerosol generators. In the final stage, delivery will be tested in model nasal cavities and performance evaluated via imaging studies.

At the conclusion of this project, the team will have developed a technology that can be used to treat chronic lung inflammation. The technology could however also be utilised for a number of other commercial applications, including the improved delivery of fertilizers and pesticides.

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READ MORE ABOUT THIS RESEARCH AND THE PEOPLE BEHIND IT

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**FAST FACTS LEARNING**

- **842** Undergraduate students
- **238** Postgraduate students
- **66** Years teaching experience
- **4** Study paths available to undergraduates.
  In 2014 most of our students took the BE (Hons) Chemical Engineering degree

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**FAST FACTS STAFF**

- **64** Academics/Researchers
- **EIGHT** ATSE Fellows*
- **TWO** ARC Future Fellows
- **ONE** ARC Laureate Fellow
- **THREE** Full-time female Professors

* The Australian Academy of Technological Sciences and Engineering
UNSW Chemical Engineering shines in Eureka Prize line-up

In fields as diverse as quantum computing, human evolution, water use and solar power, nine UNSW researchers and a collaborative research team are finalists in this year’s prestigious Eureka Prizes.

UNSW Chemical Engineering is shining ever bright with two respective finalists among the ranks, Dr Rita Henderson and Associate Professor Kondo-François Aguey-Zinsou.

The Australian Museum Eureka Prizes are the country’s most comprehensive national science awards, honouring excellence in Research and Innovation, Leadership, Science Communication and Journalism, and School Science.

There are 49 finalists in the running for 16 prizes worth a total of $160,000.

“The Australian Museum is proud to recognise the best of Australian science through the Eureka Prizes and this year’s finalists are extremely impressive,” Kim McKay AO, Director and CEO of the Australian Museum said.

Recognised for her leadership is Dr Rita Henderson, from the School of Chemical Engineering. Dr Henderson – an internationally recognised expert in water sustainability – is a contender for the 3M Eureka Prize for Emerging Leader in Science for her world-class program of research, advocacy and outreach.

In other categories, three UNSW researchers are vying for the ANSTO Eureka Prize for Innovative Use of Technology.

► Associate Professor Kondo-François Aguey-Zinsou, from the School of Chemical Engineering, is a finalist for developing the Hy-Cycle, Australia’s first hydrogen-powered bicycle.

► Scientia Professor Martin Green and Dr Mark Keevers, from the School of Photovoltaic and Renewable Energy Engineering, are shortlisted for their work delivering the highest efficiency ever reported for converting sunlight into electricity.

The Australian Museum Eureka Prize winners will be announced at a Gala Awards Dinner at Sydney Town Hall on 26 August 2015.

Details about all the 2015 Australian Museum Eureka Prizes finalists are now online at australianmuseum.net.au/eureka.

READ MORE ON THIS STORY
In many ways, Australia is a microcosm of the challenges facing the world in emissions reduction.

As the world prepares for COP21 in Paris this November, it’s timely to reflect on Australia’s role in recent years in supporting the stabilisation of greenhouse gases in the atmosphere and how Australian business, industry, research organisations and governments can continue to contribute to solutions aimed at keeping global warming below 2°C. Since the establishment of the UNFCC in 1992, Australia’s commitment to emissions reductions has had its ups and downs, variously leading and trailing the world in best practice reality and rhetoric. As a nation we have had some great achievements, including monitoring large-scale emissions from business and industry, providing incentives for businesses to find innovative ways to reduce emissions, backing energy efficiency measures, and supporting new renewable energy installations. We also supported the early development of clean coal technologies such as carbon capture and storage (CCS), and, established the Global Carbon Capture and Storage Institute to share international expertise and advice on CCS. But in the last couple of years, just as others such as the USA, China and the G7 start to take up the challenge in earnest, we have been losing momentum.

In many ways, Australia is a microcosm of the challenges facing the world in emissions reduction. Here it is important to understand that greenhouse gas emissions are not only associated with coal-fired power stations. Somewhere between 20-30% of Australia’s emissions come from these power stations along with about 60-70% of the electricity. The rest of the emissions come from industry, agriculture, transport and a range of other sources. So restructuring our electricity supply and industry to achieve either zero emissions or at least carbon neutrality is an enormous national challenge: technically, economically and socially.

This is not to say that technologies do not exist. Renewable energy production, new high efficiency fossil fuel power plants, CCS and green manufacturing exist. But they are not ubiquitous and must compete with current technologies that operate well in the prevailing political and industrial environment. If newer technologies are to become more universal, their costs need to decrease and efficiency and reliability increase from current rates. Achieving ideological nirvana without good economic policy risks decimating Australia’s economy, while plunging an entire generation into energy poverty and unemployment. Wise policy is one of the major pieces of the puzzle that is absent in the current political landscape.

This is where research, industry and governments need to come together in Australia. With our team at UNSW Australia, we have been working with the support of industry through the CO2CRC Ltd to understand the role that CCS and other clean coal technologies can play in transitioning Australia to a low carbon economy. Some of our most recent research focuses on how the phased introduction of new power plant technologies into the National Electricity Market between 2020 and 2050 can increase emissions reduction, while lowering the increases in electricity costs and ensuring continuity of supply. We are also identifying how different capture technologies need to be improved in order to significantly reduce their overall costs as well as investigating the trade-offs in pipeline routes and storage site selection on the costs of CCS. Our results show that clean coal technologies can be just as cheap if not cheaper than renewable technologies in transitioning to a low carbon future. But, like renewable technologies, the right policy drivers will need to be put in place to drive this transition.

Our research would not be able to achieve these insights without the valuable interaction we have enjoyed with industry through the CO2CRC Ltd. All too often this support is lacking in Australia, not least because of constant changes in signals from the Government and industry on how this interaction should function. We also spend far too much time arguing about whether university research outcomes are valuable. The truth is research is research and it takes time. Some research will succeed, some won’t. And while the best research outcomes often come after several failed attempts, no outcomes will arise from dead ends. The best industry-University partnerships come about when both parties understand this and work together to maximise the outcomes for each other.
An article produced by a group of researchers including Professor Vicki Chen (Head of UNSW Chemical Engineering) has been marked as a ‘HOT’ paper. Their paper was recommended by referees and selected amongst all articles published in Journal of Materials Chemistry A during 2015.

Titled ‘Preparation of titania based biocatalytic nanoparticles and membranes for CO₂ conversion’, the article explores how Novel TiO₂ based biocatalytic nanoparticles and membranes were prepared, which can be used for CO₂ conversion in gas-liquid membrane contactors.

Abstract

A biomimetic route for CO₂ conversion catalyzed by carbonic anhydrase (CA) is an attractive option for carbon capture and storage due to the high efficiency and specificity of CA in CO₂ hydration.

The preparation of TiO₂ based biocatalytic nanoparticles and membranes via CA immobilization facilitates the reuse of the enzyme and could be potentially integrated in a gas-liquid membrane contactor for highly efficient CO₂ capture. In this work, different immobilization protocols were compared based on CA loading, activity and stability.

For biocatalytic nanoparticles, over 80% activity recovery corresponding to 163 mg g⁻¹ support was achieved. Repeated reuse and recovery of the biocatalytic nanoparticles over twenty cycles showed only modest loss in activity. For the biocatalytic membranes, the nanostructure of the titania coating and the pH values during immobilization were examined to optimize the biocatalytic performance.

Biocatalytic membranes prepared at pH 6 with two cycles of sol-gel coating were able to immobilize a 700 ug CA per cm² nominal membrane area. The CO₂ hydration efficiency of the biocatalytic nanoparticles and membranes was examined, and only marginal loss of catalytic efficiency was observed when compared with their free CA counterpart, indicating good potential for application of such biocatalytic nanoparticles and membranes for CO₂ conversion.

VIEW FULL ARTICLE
The Australian Laureate Fellow is developing a revolutionary way to use water and solar energy to recycle carbon dioxide into environmentally friendly fuels.

Scientia Professor Rose Amal calls her planned system for sustainable fuel production “deliberately ambitious.”

Using only energy from the sun, she aims to split water to liberate its hydrogen and then to hydrogenate carbon dioxide in a second reaction to create a new generation of commercially viable, renewable fuels.

To develop fuels that are based on environmentally neutral H2O and sunlight, and at the same time recycle increasingly problematic CO2 from our atmosphere, would be an incredible achievement. It would mean two of our most critical global issues would be addressed simultaneously – energy security and human-induced climate change.

“Now, as chemical engineers, we are looking at harnessing solar energy, not to convert into electricity, but for chemical reactions to create new fuels.

“This would overcome the current limitations of solar power, because fuels can be stored and used when needed, not just when the sun is shining.”

It’s an elegantly simple plan, but to convert and store this chemical energy will require extraordinary creativity, innovation and breakthrough knowledge. Currently, sourcing hydrogen from water uses much more energy than is created. The reduction of carbon dioxide is also an ‘uphill’ reaction, meaning a great deal of energy is needed to pull apart the strong bonds that bind carbon and oxygen together as a stable gas.

But Amal – a Fellow of both the Australian Academy of Science and Australian Academy of Technological Sciences and Engineering – has a highly original idea at the interface of science and engineering, and is using her recently announced Laureate Fellowship grant to demonstrate its feasibility.

As the leader of UNSW’s Particle and Catalysis Group, Amal is a globally recognised pioneer and authority in the fields of particle technology, photocatalysis and functional nanomaterials. Named in the top 100 most influential engineers by Engineers Australia, she is perhaps best known for her work on the ‘self-cleaning bathroom’ – creating highly specialised ‘nano’ surfaces that trap light from the sun, enabling air and water to be purified.

Boosting the energy conversion efficiency in photocatalysis will be essential to creating the new generation of sustainable fuels, Amal believes.

“Thousands of papers on new photocatalyst developments have been published. However, the research has been fragmented and the improvement in the overall energy conversion efficiency has been marginal,” she says.

“We require a system-wide approach, which means understanding the basic science, developing new materials, and engineering the right hybrid system to deliver practical, real-world applications.”

Amal admits it is still early days. Nevertheless, she is encouraged by the interest in her work. “If successful, we would have an almost ideal outcome in terms of sustainable energy and clean environment.

“And we would reinforce Australia’s position as a major player in the global renewable energy market.”

READ MORE ABOUT OTHER WOMEN WHO ARE CHANGING OUR WORLD.
FAMS2015 – Reducing the impact of food allergy

Inaugural Food Allergen Management Symposium
11-14 May 2015

In May 2015, 130 delegates from Australasia, Europe, and North America met in Sydney to share their experiences and discuss strategies for more effective food allergen management.

FAMS2015 showcased cutting edge research in food allergy and allergens, with the overarching goal of reducing the impact of food allergy though a holistic approach. Dr Fiona Cameron (Executive Director, Australian Research Council) opened the meeting with a special welcome message from the Hon. Karen Lesley Andrews, Deputy Minister (Federal Parliamentary Secretary) for Industry and Science, Australia

FAMS2015 (Food Allergy Management Symposium) was the first food allergen management symposium held in Australia and the first open forum convened between scientists, professionals and other industry stakeholders in the Southern Hemisphere. The symposium also provided a unique forum for patient groups, clinicians, dieticians, and food industry representatives, who led a thought provoking discussion on the current status of precautionary allergen labelling (PAL).

Food allergy is a significant food safety challenge for the food and associated industries globally, with a great impact on consumers. The financial burden and the socio-economic impact of allergen management can amount to billions of dollars.

The symposium has helped to build food allergy and allergen networks, and solidified the goal of making this world free of food allergy through an holistic approach.

READ MORE ABOUT FAMS2015

New international partnership with major aluminium producer

Professor Jie Bao, Emeritus Professor Maria Skyllas-Kazacos and Professor Barry Welch are working on a new project in collaboration with EGA (Emirates Global Aluminium), formerly Dubai Aluminium Company. EGA is one of the largest manufacturers of aluminium, producing 4% of the world’s aluminium.

Their project involves monitoring and control of aluminium smelter operations. Professor Jie Bao said, “We have developed a new instrumentation scheme which helps the company monitor smelter operations in real time. We have created algorithms to automatically detect abnormal operating conditions. This improves the efficiency of operation and also improves safety and reduces the environmental impact”.

The project has been running since 2013 and will continue next year.
In profile: A/Prof Pierre le Clech

Associate Professor Pierre Le Clech has long had a keen interest in environmental protection and clean technologies. Since completing his PhD at Cranfield University in the UK, Pierre has worked to develop his expertise in wastewater treatment and advanced treatment processes. In 2003, Pierre joined the UNESCO Centre for Membrane Science and Technology (UNSW), where he is now an Associate Professor in the School of Chemical Engineering.

Pierre has studied many aspects of the use of membrane technologies for water and wastewater treatment and recycling. Out of his early work, one of Pierre’s review papers, titled ‘Fouling in membrane bioreactors (MBR) used in wastewater treatment’, has recently reached more than 1000 citations (according to Google Scholar). Written in 2006 and published in the Journal of Membrane Science, the paper critically reviewed more than 300 studies focusing on fouling in membrane bioreactors (MBRs), an advanced process increasingly used in wastewater treatment and recycling processes.

Pierre currently leads four studies funded by the National Centre of Excellence in Desalination Australia, with topics ranging from reuse of reverse osmosis modules, to novel operating conditions for forward osmosis. Some of the most practical outcomes of this work include an interactive tool for facilitating decision making of the fate of reverse osmosis at the end of their practical life time. This web-based tool will be presented at the upcoming International Desalination Association (IDA) World Congress in San Diego, along with four other papers dealing with important desalination research activities.

Of significant impact to the local water industry, is a project of Pierre’s that aims to define the national validation guidelines for the use of MBR for water recycling. Funded by the Australian Water Recycling Centre of Excellence, this $6 million project (conducted in collaboration with key Australian universities) will help the relevant stakeholders to more easily install and operate MBR and produce recycled water in Australia.

Pierre takes great pride in the recognition of the wonderful work conducted by his PhD students. His student Amos Branch recently received best presentation award at the Australian Water Associate annual conference, and Gaetan Blandin has been invited as the main guest speaker of a recent web-seminar organised by the Global Water Intelligence (Desalination) on pressure assisted osmosis (PAO) process.

Pierre has a busy six months ahead, in particular with the upcoming International Desalination Association World Congress and five papers to present, and an invitation to spend a week at the University of South Africa to discuss research programs and collaborations with local and Belgium partners, organised by the Global Water Intelligence (Desalination) on pressure assisted osmosis (PAO) process.

What are you currently excited about, for e.g. any recent innovations or new products that you are working on?

I am really excited about a new Popcorn product we recently launched – ‘Poptopia’. A great new snack with 50% less fat than typical snacks, but with great flavour and texture which are novel for Popcorn products. This is a new to the world product with a unique process and recipe.

What would your advice be for young engineers/researchers who are at the start of their career?

A few suggestions:

- I would encourage young people to get broad exposure as early on as possible in their careers. This help you understand where your passions/strengths/likes are.
- Also, create and foster networks, they may be your best bet in finding opportunities.
- Find experienced mentors to give you advice. Communication and people skills are just as important as your technical skills, make sure you are improving these as well.

School alumnus Malcolm Thompson leading R&D at Green’s General Foods

Malcolm Thompson graduated from UNSW in 1986 with a BSc (Hons) in Food Science. He has since forged a career at industry ‘Blue Chip’ organisations including Mars, PepsiCo and YUM. Malcolm currently heads R&D at Green’s General Foods.

In this Q&A, Malcolm gives us his insights into the industry and how science can best have an impact.

Where did it all start? What interested you about this discipline and why did you decide to study Food Science?

Originally (like many students). I had no idea what I wanted to do when I went to University. I started a Chemistry Major at UNSW, and, after six months, decided that it wasn’t for me. I chose Food Science as it had more of the things I liked studying (Biology/Chemistry) and less of the things I was not so good at (Physics). Also, it was applied enough that I could see a practical outcome from a career perspective. I was fortunate enough to get a job with Master Foods from University and have spent my entire career in Food R&D in FMCG (fast-moving consumer goods) companies ever since.

How do you see the impact of research on industry activities?

Industry has constant pressure to:
(i) ‘Grow the top line’ - increasing sales from either existing business or from new markets/products, and to
(ii) ‘Grow the bottom line’ - driving profitability via improved productivity and efficiency’s.

Typically industry uses ‘known’ solutions to do this via commercially available ingredients, processes and technologies. Research helps develop ‘new solutions’, the new ingredients, processes and technologies, which industry can adapt and deploy for new business and create more profit. Connecting the science to ‘the problem’ is key for applied research to have industry impact.

“Connecting the science to ‘the problem’ is key for applied research to have industry impact.”
In profile: A/Prof Cyrille Boyer

Following his passion for science at school, Cyrille Boyer pursued his studies at the University of Montpellier and Ecole Nationale Superieure de Chimie in Montpellier (France), earning a PhD in polymer chemistry from the University of Montpellier II (awarded in 2007).

Joining UNSW Chemical Engineering (where he is the member of two research centres - the Centre for Advanced Macromolecular Design and Australian Centre for Nanomedicine) in 2007, Cyrille’s passion remains evident as he tackles major challenges in environment, health and energy.

Cyrille has many research interests but as an engineer he always has one objective, namely working towards the development of new methodologies to solve important problems.

One of his research areas focuses on the transformation of solar energy into chemical energy, which will reduce energy consumption and toxic chemical waste. In this research, Cyrille is interested in developing new methods to activate polymerization using visible light with the aim of producing new materials for drug delivery and energy storage. Cyrille explains, “the use of light allows us to manipulate the polymer properties and to generate unique materials, with unprecedented properties (such as 3D surface, or 3D objects)”. As Deputy Director of the Australian Centre for Nanomedicine, Cyrille is also dedicated to the development of new smart nanomaterials for the precise delivery of therapeutic molecules. The objective here is to improve the efficacy of therapeutic molecules for the treatment of important diseases such as cancers and infectious diseases. In this research the group prepare nanomaterials for the treatment of microbial biofilms. This is particularly relevant to healthcare facilities and hospitals, whereby healthcare-associated infections (HAIs) are rapidly spread. There are around 200,000 HAIs in Australian acute healthcare facilities each year (Australian Guidelines for the Prevention and Control of Infection in Healthcare, 2010) costing the government several billions of dollars. In this approach, his team is developing materials capable of dispersing and killing these biofilms.

Extending his research activity to energy, Cyrille is also interested in developing new solutions for the hydrogen storage, investigating a combination of inorganic materials and polymers.

With colleagues from Singapore, some of Cyrille’s research on the delivery of carbon monoxide (CO) for the treatment of bacteria has just been published in Biomacromolecules. In this research, they demonstrated a new way to deliver CO in a controlled manner using polymers. In addition, they could demonstrate that CO can kill bacteria at a very low concentration. This could be an alternative approach for the development of new antibacterial agents.

In profile: Dr Rita Henderson

With degrees from Edinburgh University (Environmental Chemistry) and Cranfield University (MSc Water Pollution Control Technology and PhD on algae treatment using a novel dissolved air flotation process) in the UK, Rita Henderson joined the UNSW Water Research Centre to continue her research in water treatment and biotechnology.

Rita now leads the bioMASS lab at the UNESCO Centre for Membrane Science and Technology (UNSW) and is a Senior Lecturer in the School of Chemical Engineering.

Her research specifically focuses on the design, optimisation and monitoring of solid-liquid separation processes designed for microalgae and organic matter in the context of both water treatment and biotechnology.

In Australia, where water supply is unreliable in many parts of the country, communities look to science and engineering to provide smart and innovative technologies that can address water security issues.

Rita’s research aims to optimise water treatment process performance and increase efficiency in terms of chemical and energy consumption, particularly for source water impacted by algal blooms. Her group also investigates ways in which to improve on-line monitoring of processes that are used to treat algae such that operational decisions, for example, coagulant dose, can be made more quickly.

The impact of Rita’s research extends to alternative fuels as the same processes that are applied for separating algae in water treatment plants can be used for harvesting algae as a source of biofuel. As the separation process is one of the major costs associated with using algae as a biofuel, any improvement in efficiency will increase its potential as an economically viable fuel source. She recently attended the 5th International conference on Algal Biomass, Biofuels and Bioproducts in the USA to demonstrate how this research can be applied to separate algae in the context of harvesting for biofuel.

Rita is one of a number of inspiring women at UNSW Chemical Engineering who believes “Encouraging women into STEM subjects is critical and female role models in senior positions can really help to show female students that the career path exists”.

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Rita is one of a number of inspiring women at UNSW Chemical Engineering who believes “Encouraging women into STEM subjects is critical and female role models in senior positions can really help to show female students that the career path exists”.

And Rita’s advice to young women who would like a postgraduate career in engineering: “be confident in your abilities, grab those opportunities and seek out a mentor in the field that can help guide them through their career”.

Rita is a finalist for the 3M Eureka Prize for Emerging Leader in Science, the awards night will be on 26th August.

READ MORE ABOUT CYRILLE BOYER

READ MORE ABOUT RITA HENDERSON
Science and Engineering isn’t just for ‘boys with toys’

Earlier this year a social media campaign in protest of a common stereotype proves that women in STEM (Science, Technology, Engineering and Maths) are stronger than ever! Female scientists and engineers around the world are posting photos of themselves with their tools and equipment to social media sites using the hashtag #GirlsWithToys. UNSW Chemical Engineering staff and students have also participated by sharing some great shots of their research equipment and subjects.

FROM THE TOP (left to right)

Prof Maria Skyllas-Kazacos from UNSW School of Chemical Engineering with her vanadium redox battery. #vanadium-redox-battery #girlswithtoys

Jie Song about to study cellulose nanofiber gel yield stress #rheology #girlswithtoys @UNSWEngineering #complexfluids

Prof Rose Amal making a nanocatalyst for CleanEnergy in her furnace. #nanocatalyst #GreenEnergy #ChemicalEngineering #CleanEnergy #ComplexFluids

A/Prof Jayashree Arcot at UNSW School of Chemical Engineering using hydrostatic high pressure to enrich foods. #foodscience #foodtechnology #nutrition

Shirin Dabestani recovering protein from veg processing wastewater #girlswithtoys #RealTimeChem

Prof Vicki Chen and her high pressure #desalination #membrane filtration equipment. #girlswithtoys

Research student Rabiatul Haji Abd Halim studying silica dispersions with a benchtop NMR at UNSW School of Chemical Engineering #n宾客withtoys #RealTimeChem

UNSW researcher Jaleh Mansouri force spinning to make thin spacers for dye-sensitised solar cells #girlswithtoys #solarpower

“Setting up my daily routine! Me and my baby :) #microrheology #biofilmgunmodel #girlswithtoys @UNSWEngineering” – Goldina Kwandou

PhD candidate Fitri Faradilla of UNSW School of Chemical Engineering saving the world: from plant waste fibre to bioplastic. #girlswithtoys

Dr Alice Lee using chromatography to search for super peanuts #GirlsWithToys #FoodAllergy #FoodScience #FoodTechnology

“With my everyday toy - reverse osmosis testing rig #girlswithtoys” – Alice Antony
Would your community cope if disaster struck?

Two UNSW Chemical Engineering students head to Amsterdam after winning the 2015 Australia-Netherlands Water Challenge.

An innovative ‘Resilience Index’ that measures the ability of communities to cope with natural disasters, developed by two UNSW Chemical Engineering students, has won first-prize in a national competition to address the challenges of climate extremes. The Index, created by Tracey Lloyd and Tom Perfrement, was one of two winning ideas in the 2015 Australia-Netherlands Water Challenge, a joint government initiative that aims to foster innovative ideas and develop future leaders in the field. The pair, both UNSW Co-op Program scholars, will travel to Amsterdam in October with fellow winners Ashlee Clarke and Raymond Laine, from the University of Wollongong, for a three-week traineeship to develop their project and to take part in International Water Week.

Tracey and Tom were the only undergraduate students in the finals, held at the Floodplain Management Association Conference in Brisbane in May. "We are passionate about helping Australia strengthen its resilience in the face of climate change and we are really looking forward to working with experts from Australia and the Netherlands to further develop our ideas," says Tracey. "To define and pinpoint what resilience is and how it can be measured was a good topic for exploration," says Tom. "A number of standards and indicators exist for gauging resilience but there is currently no consensus for a quantitative measurement.''

The Index takes into account community factors such as the social, economic and natural environment and combines them to create a ‘resilience’ score out of 100. Communities can then use this score to evaluate their risk and target strategies to improve preparedness. Information from 11 local government areas in Brisbane was used to create the Index, but the pair say the model could be applied to any community around the world.

Resilience Index is a manipulation of individual variables to produce an aggregate measure of resilience.

"A number of standards and indicators exist for gauging resilience but there is currently no consensus for a quantitative measurement," he said.

Tracey and Tom are both involved in the UNSW Co-op Scholarship Program, which incorporates industry experience, leadership and professional development as well as financial assistance for their degree. As part of their Co-op Program Scholarship they are currently on placements with water resource companies, which have been very supportive of their involvement in the competition. Tom says the Index has gathered a significant amount of interest from industry and government and hopes their trip to the Netherlands will further cement support for the project. The Composite Disaster Resilience Index is a manipulation of individual variables to produce an aggregate measure of resilience.

READ MORE ON THE RESILIENCE INDEX WEBSITE

Computational Pharmaceutics’ book edited by Prof Sean Smith & Dr Defang Ouyang

Professor Sean Smith of UNSW Chemical Engineering and Dr Defang Ouyang Assistant Professor at the University of Macau are the editors of a new book called Computational Pharmaceutics: Application of Molecular Modeling in Drug Delivery, first edition published in 2015 by John Wiley & Sons Ltd.

This book provides an overview of the application of computational modelling techniques to problems relating to pharmaceutics (drug delivery and formulation development).

About the book

Computational pharmaceutics involves the applications of computational modelling to drug delivery and pharmaceutical nanotechnology. In combination with existing branches of pharmaceutics, it offers rapidly growing potential for developing rational, deductive and knowledge-based strategies in pharmaceutics.

Computational pharmaceutics has the ability to provide multi-scale lenses to pharmaceutical scientists, revealing mechanistic details ranging across chemical reactions, small drug molecules, proteins, nucleic acids, nanoparticles, and powders to the human body. Written for an audience with little experience in molecular modelling, with a focus on applications, this book is suitable for researchers and students working in pharmaceutics sciences and computational chemistry. It is also an excellent resource for those working in medicinal chemistry, materials science and nanotechnology.

READ MORE ABOUT THE BOOK
When Professor Jimmy Yun moved to Singapore unexpectedly 17 years ago, he didn’t realise the decision would change his life. Not only did it deepen his relationship with UNSW, it led to a successful entrepreneurial career.

In 2012, UNSW appointed Jimmy as Adjunct Professor of Chemical Engineering and, in May this year, Dean of Engineering Professor Mark Hoffman gave him a part-time professorial role. “Jimmy checks two boxes,” Mark says. “He is enabling research here [at UNSW] and connecting us with industry and government in China. I’m very keen to get UNSW involved in major projects in Asia.”

The early years and UNSW

After Jimmy spent his childhood in Hong Kong, his family immigrated to Sydney and he attended De La Salle College in Ashfield. “I was a rare breed – I really enjoyed doing Chemistry,” he says. “I was really fascinated by it and wanted to do a practical degree.”

Although initially enrolling in another university, Jimmy switched to UNSW. “It wasn’t the hardware of UNSW that attracted me but the people,” he says. “It seemed really welcoming to overseas students. From the beginning, I felt a real sense of belonging, so much so that I stayed there happily for eight years.”

Jimmy graduated with first-class honours with a Bachelor of Engineering (Chemical) in 1988, with Professor Neil Foster as his supervisor. He then stayed with Neil throughout a PhD, in the application of super-critical fluid technology, until 1992. “Neil helped open my mind to emerging technologies for the first time,” he says.

His PhD success led Jimmy – accompanied by his new wife, Dr Michelle Liew, also a UNSW PhD graduate and an environmental engineer – to take up post-doctorate research fellowships. He was first with the Hokkaido National Industrial Research Institute in Japan and then the Georgia Institute of Technology in the United States.

The young couple returned to Australia to start a family but within two years Michelle was offered a job opportunity in Singapore. “Usually in our Chinese culture, the man does not follow the woman,” says Jimmy, smiling. “But we thought about the opportunity for a few weeks, and felt peaceful about it, so we moved to Singapore.”

The Singapore story

Within days of landing in Singapore, Jimmy found a job in a start-up technology company, Lucus Origin. The year spent meeting potential investors and government officials opened his eyes to an exciting world of entrepreneurship. He added to his knowledge tool-kit by getting positions with the Singapore Government’s National Science and Technology Board, overseeing a multi-million grant portfolio and, a year later, becoming technical manager at NatSteel Chemicals.

When a colleague’s nanotechnology concept was knocked back, Jimmy and the researcher left to launch their own start-up, NanoMaterials Technology (NMT), in 2000. “Everyone starts companies for different reasons,” Jimmy says. “I started NMT because I was passionate about the technology, the specialised nanoparticle design. That is what drove me.”

By the time Jimmy sold the business in 2012, NMT was developing, manufacturing and commercialising nanomaterial products for multinational companies. These were used in projects involving oil and gas, coatings, plastics, glass, electronic materials and pharmaceuticals. NMT had more than a dozen patents granted and employed more than 30 research staff, mostly PhD graduates.

From 2005 to 2008, NMT had two Australian Research Council grants with UNSW. In 2006, the last 15 years,” Jimmy says. “What they’re seeking now is active collaboration with Australian universities and industry, so it’s a win-win situation when both benefit from each other’s leading-edge technology.”

Jimmy also oversees PhD researchers, imbuing students with entrepreneurial thinking. Last year, he was elected as a Fellow of the prestigious Australian Academy of Technological Sciences and Engineering. “Because Jimmy speaks his mind, and at the same time understands the Chinese business culture, he’s a great facilitator and an asset to UNSW,” Neil Foster says. “He’s a brave academic, as well as an entrepreneur prepared to take risks.”

Research Partnerships

UNSW offers a diverse range of opportunities for all of our alumni to engage and participate in an exciting range of projects and activities. These include:

- Student scholarships, internships and project
- Student enterprise and entrepreneurship
- Contract research and consulting
- Intellectual Property licence through our innovative “easy access” framework
- Use of world class facilities and laboratories
- R&D Projects utilising government incentives

If you would like to know more please contact Warwick Dawson, Director, Research Partnerships via email or 02 9385 7929.

Neil and Jimmy started collaborating with the Beijing University of Chemical Technology (BUCT).

The future

After selling NMT, Jimmy capitalised on his well-established networks and has been involved in various start-ups and joint ventures with innovative technology companies across China.

In 2013, Jimmy and Neil established a laboratory with BUCT’s Changzhou Advanced Materials Institute in Changzhou, Jiangsu Province. Jimmy has also developed research partnerships between UNSW, the Chinese Government and private industry. He has initiated two delegations from southern China to UNSW over the past 18 months, leading to memorandum of understandings of understanding. Changzhou city officials visited UNSW last December and met with then Vice Chancellor Fred Hilmer. “China has come an amazingly long way in
UPCOMING

► APSPIS: 2nd Asia-Pacific Symposium on Process Intensification & Sustainability - 20-22 September 2015
Find out more: http://www.apspis2015.com/

► UNSW Chemical Engineering Alumni Event - 29 September 2015 at APCChE Congress Melbourne (http://www.apcche2015.org/)
Find out more: https://www.engineering.unsw.edu.au/chemical-engineering/all-events/alumni-friends-event

► Future Energy Conference 4 - 6 July 2016
Find out more: http://www.ozenergyfuture.com/

► UNSW Energy Future Collaborative Innovation Awards 2016
Find out more: http://www.ozenergyfuture.com/program/unsw-energy-future-collaborative-innovation-awards-2016/

RECENT

► Membrane Workshop –18 June 2015
Many Australian research groups have recently invested in desalination research, especially within novel desalting technologies and the use of forward osmosis for desalination and water treatment. A range of strategies studied by Australian researchers were discussed during the workshop and offered the opportunity to showcase the latest findings for a number of NCEDA projects.

► Sassy Meeting –10 June 2015
The Complex Fluids Group hosted researchers from in and around Sydney for a one-day micro-symposium. The inaugural Sydney Surfaces and Soft Stuff meeting (Sassy2015) brought together 45 researchers from UNSW, ANSTO, Sydney University, Newcastle University, UWS and ANU. Excellent talks on recent research were complemented by a poster session and some great discussions. The meeting is set to become an annual event. Please contact Dr Stuart Prescott for more details. (https://research.unsw.edu.au/people/dr-stuart-prescott)

► High Strength Wastewater Management Workshop – 9 June 2015
The objective of the workshop was to connect industry and academia to discuss challenges and novel solutions for the management of waste from biofuels, food and allied industries.

► Industry Breakfast – 1 May 2015
The Industry Breakfast was planned to begin a conversation between UNSW Chemical Engineering and a number of industry professionals that explores potential opportunities for collaboration, particularly in key areas of energy, environment, health, polymers & colloids and product & process engineering.

► Advances in pre-treatment processes for desalination workshop – 26 February 2015
Australia has recently invested towards desalination research, and many studies currently focus on enhancing pre-treatment performances, in order to obtain a more sustainable desalination process. Organised by A/Prof Pierre Le Clech and Adhikara Resosudarmo from UNSW Chemical Engineering (UNESCO Centre of Membrane Science & Technology), the workshop featured presentations by upcoming and established researchers as well as industrial delegates from DOW, Xylem, NuSep, Evoqua, Veolia, BASF and Orica.

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