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Changing Australia, Changing the World Social Engagement @ Civil & Environmental Engineering

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Engineering

School of Civil and Environmental Engineering



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Printing:

FAASTPRINT

FSC:

Recycled, chlorine free paper

CRICOS Provider No: 000098G



Welcome Contents



It gives me great pleasure to share with you - our alumni, industry colleagues, and student communities – just some of the ways in which UNSW Civil and Environmental Engineering is involved in advancing a more prosperous, safe and just society.

Engineers have always been people of action – driven to create, to solve problems, to make things happen, and to make a difference. Our current students and staff are no exception.

In this special edition of School news we explore a range of activities – from our participation in Engineers without Borders to a social justice project at home, the inspirational student-led project eReuse.

We look at the impact of just some of our academic staff who engage with disadvantaged and marginalised communities in Australia, the Asia Pacific region, and elsewhere.

We also profile some of our top scholars who through their leadership in research positively influence global trends in areas such as safe building structures, GPS systems, international water quality guidelines, transport modelling, real measurement of national footprints, and effective transnational waste management.

For such a large School as ours, even this special issue can only provide a partial picture of all the great work our staff and students are involved in. The stories will still, I hope, show just how diverse, ambitious, compassionate and creative our people are.

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Professor and Head of School

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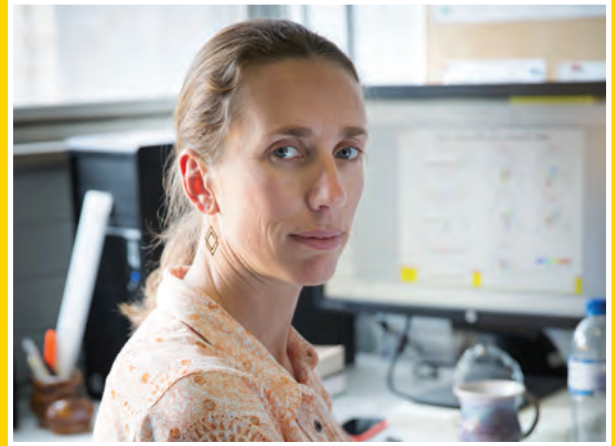
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Between the real and the ideal: Engineers without borders



ENGG1000 2015 EWB project. Dr Fiona Johnson (with watering can) and students.



The humanitarian engineering organisation Engineers Without Borders (EWB) has a long standing and multi-faceted relationship with the School of Civil and Environmental Engineering. EWB, as a member-based, community organisation, creates social value through engineering, working towards improved living standards in water, housing, sanitation, education, infrastructure, agriculture, communication, energy and digital access across the globe.

The requirement for membership is that you are passionate about creating a better world, about engineering people out of poverty. As CVEN surveying student Karats Eisenmenger says “I wanted to be a part of something that can really make an impact in the wider community.”

UNSW Engineering staff and students are so committed to a continuing and meaningful partnership with EWB that the alliance forms part of the first year curriculum, as an elective project within the Faculty-wide course Engineering Design and Innovation (ENGG1000). In this project, all UNSW engineering students, along with other engineering students across the globe, are invited to respond to the annual EWB Challenge. Student teams compete to create a real life solution for a real life problem.

In 2015 students were asked to design a system for collecting rain water to prevent flooding, improve sanitation and encourage water conservation

appropriate for the rural community of Bambui, in the North West region of Cameroon.

Bambui is undergoing rapid urbanization following the construction of a new university in 2012, an urbanization which has increased the pressure on water supplies, sanitation, waste management and housing. Students were asked to design and construct a system for an individual house or building that would a) capture rainfall; b) have a first flush system to prevent contamination; and c) allow for the easy and safe reuse of the water within a house or school. The 2015 challenge partner was Reignite Action for Development, based in Bambui, Cameroon.

In a year where global movements of displaced peoples have risen to distressing levels, the 2016 Challenge was mediated by the United Nations High Commission for Refugees.

Over the last 5 years Zambia has agreed to accept 14,000 Angolan and Rwandan refugees. Land has been set aside to develop communities where these refugees will live side by side with local Zambians. International support has been sought for assistance and solutions in areas such as water, shelter, communications, infrastructure and waste. In their very first year of study, engineering students have been asked to meet these challenges creatively and, first hand, to witness the power the discipline of engineering has to positively affect lives.



EWB High School Outreach Training Day at UNSW
CVEN EWB student organisers Melinda Jiang far left, Karats Eisenmenger, back row, last right.

The UNSW chapter of EWB is largely run and managed by students. These students, already juggling full time study and paid employment, find the time to take on time consuming responsibilities. CVEN student Melinda Jiang says the time she donates is “too much to count, but I would happily do more.”

These students, in their turn, reach out to other younger students in the School Outreach Program. This program is extended out, away from city centres, in the Regioneering Program, which Karats Eisenmenger calls a “blast”: “Seeing students light up, knowing they can make a difference is hard to forget.” So the cycle continues: young, engaged, concerned and vigorous engineers-in-training carry the word to other, even younger people willing and wanting to listen and help.

Perhaps most significantly EWB seeks to right the wrongs in our own back yard. In recent years it has provide technical support for the restoration of the beloved and dilapidated La Perouse Mission Church: a building of huge cultural significance to the local Aboriginal community.

The UNSW chapter also reaches out to refugees settled in Sydney through the Sudanese Australian Integrated Learning program (SAIL), providing invaluable in-kind and financial support to this volunteer organisation, running STEM workshops for 6-12-year-old refugee children.

Even a cursory glance at the UNSW EWB Chapter Facebook page reveals the broad range of vigorous activities: from Outreach Training days to a Sustainable Water Systems workshops to a Coding for Social Change seminar.

Gender diversity is addressed through the connection to Women Without Borders. One post asks “Can a humanitarian focus help alter perceived gender stereotypes within engineering?” Perhaps it already has. A clear majority of executive positions in UNSW EWB chapter are held by women and there is a higher ratio of women involved in EWB generally, when compared to the wider engineering community.

School academic Dr Fiona Johnson co-chairs the UNSW-EWB partnership which provides further opportunities for students to integrate humanitarian engineering with their studies. She encourages her students toward humanitarianism and altruism. “Lots of undergraduates are idealistic and passionate, wanting to know how they might make a difference in the world. If we can inspire them and give them the skills to affect those changes, then that’s pretty cool.”

Dr Johnson tells her students that undergraduate studies are “the best time of your life”, but that it is about “more than just learning”. For her part, Dr Johnson believes it is her role to gather and harness the passion of novice engineers, temper and mature it with technical foundational knowledge, then broaden and mature it with real world realities.

Can mathematics create social justice?



Could an algorithm feed a homeless man in Sydney? Could mathematics create social justice? Associate Professor Vinayak Dixit not only believes in the ethical power of mathematical engineering; he makes it happen.

As Deputy Director of the UNSW Research Centre for Integrated Transport Innovation (rCITI), he and his team were awarded a \$150 000 ARC Linkage Grant to partner with OzHarvest in developing a holistic mathematical model to improve the efficiency of food delivery by this not-for-profit organisation. OzHarvest collects surplus food from all types of providers and delivers it, direct and free of charge, to more than 800 charities. Since 2005 OzHarvest has delivered 53 million meals, and saved 18 thousand tonnes of fresh food from landfill.

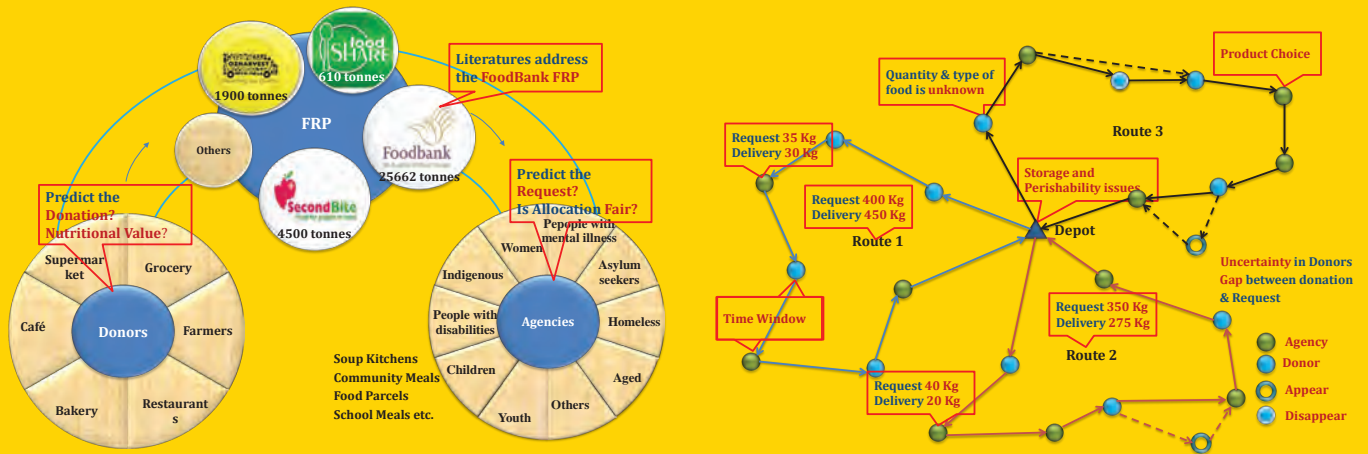
Dixit did not just do his research work from a distance, from the safety of an office. He drove around with OzHarvest delivery drivers, feeling what it was like, feeling the flow of the traffic, getting an embodied as well as a statistical understanding of what was needed. Since his involvement more food has been delivered to more people, more efficiently, using less resources.

Dixit and his colleagues (Dr Taha Hossein Rashidi, Prof S. Travis Waller, Mr Gopi Krishnan) won this Linkage grant precisely because it created a link: a connection between a university, a charitable organisation, its

clients and a government. This is the kind of social engagement that brings together people of vastly different backgrounds, using and developing innovative knowledge to collaboratively create a kinder, more liveable society. It fulfils, precisely, the obligations created by the UNSW 2025 Strategy which names 'equality of opportunity' and 'a just society' as two of the most important priorities over the next decade. The OzHarvest partnership is academic conscience in action.

But Vinayak Dixit's social engagement extends well beyond Australia. rCITI and Dixit are currently forming a research partnership with the World Bank -conducting front line surveys in Samoa about women's access to transport. In 2015 this project was awarded seeding funds from UNSW Vice Chancellor's Natural Disasters Recovery Initiative. The long term benefits for the members of this community were recognised by UNSW and have now been recognised one of the world's most powerful organisations.

In Samoa, many women do not have the ability to drive. This can have dire consequences in times of natural disaster: both in the escape from the event and during the immediate recovery period when access to medical assistance, fresh water and food is vital. There is only one goal here: supporting these women in a move toward improved security, social participation, opportunity and emancipation. Vinayak Dixit regards gender equity as vital for global social justice.



And he is uniquely qualified to handle such cross cultural projects. He has a nuanced understanding of how modelling processes need to ask sensitive and pertinent questions. Developed institutions, he believes, first need to understand the shape of the partnership. So he sees such endeavours as the World Bank project as an exchange of information, an affiliation and an encounter. How can universities and institutions learn from communities? What knowledge do these communities hold? How can their wisdom shape ours?

This is a truly global academic. Dixit was raised in regional India and has spent a good deal of time in various Asian countries immersing himself in their transport practices, developing an understanding of what it is to be part of systems he likens to rivers. How do these systems operate and flow? What problems exist here? How could we help?

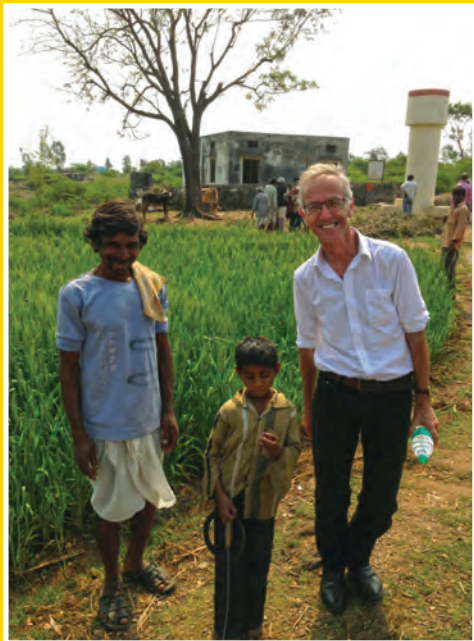
Dixit has also spent a great deal of time in developed Western nations and can see the distinctive characteristics of transport systems across the globe. While in certain communities efficient, reliable and secure transport is an assumed right, in others improved transport is a conduit to justice, equity and health.

In 2015 India's Joint Secretary of Transport visited rCITI and CVEN to investigate future collaborative possibilities. This Centre's modelling and expertise is being shared with the highest levels of Indian

government, cementing international relations with UNSW and helping people on the ground attain greater access to modern modes of mobility. Dixit's research is supported by Indian industry partners like Medulla Soft Technologies.

Associate Professor Vinayak Dixit is a mathematician and an engineer who prizes interaction with others as the most vital part of his work. He knew that transport engineering was where he could be of greatest use, where his work could have the most meaning personally and where he could belong to an international community of diverse participants united in a desire to make the world better.

Decades of research to improve human health



“The work that I’ve undertaken over the years is a mix of understanding how nature works, as well as developing new technologies for treating our water and wastewater”

Award winning Scientia Professor David Waite’s career encompasses exceptional research, international standing and a wide-ranging contribution to the field of environmental chemistry and engineering.

In his forty-year career, Waite has published more than 300 peer-reviewed articles and attracted more than \$16 million in research funding, focused upon the behaviour of elements such as iron, manganese, copper, silver and uranium in natural and engineered systems.

“The work that I’ve undertaken over the years is a mix of understanding how nature works, as well as developing new technologies for treating our water and wastewater,” Waite said.

“It’s a dual investigation of both underlying biogeochemical processes in nature, but also new technologies in water treatment.”

The impact of his work is multifaceted, ranging from improved technologies for water treatment, to better approaches to land management, to mineral extraction from tailings deposits and the management of radioactive wastes.

While Professor Waite’s research aim has been to undertake biogeochemical research which improves our understanding of natural aquatic systems, he has a larger two-fold goal in sight. He wants his work, he says, “to enable us to prevent environmental degradation, and also to develop appropriate solutions to challenges such as provision of water supply and improving human health”.

Along with colleagues Dr Peter Kovalsky and Professor John Fletcher, one of Professor Waite’s current ARC Linkage projects involves the development of a low cost robust sustainable technology for effective water treat-



ment. The main outcome is intended to be a solar-powered device for removal of salt and other contaminants from groundwater that is capable of stand-alone operation with optimal energy recovery and inbuilt monitoring – perfect for remote or developing communities around the world.

“While the core technology (of Capacitive Deionisation or CDI) has been around for a while, it’s becoming increasingly popular because it’s a low-energy technology and is also very scalable,” Waite explains. “If you want to build a small unit for a household, you can do that, but you can also scale it up to serve a community.”

The device being developed by Waite and his colleagues uses both non-redox and redox processes, with the latter a focus for generating chlorine or hydrogen peroxide in the units.

“It’s a composite technology where we can lower the salinity, we can remove trace contaminants like fluoride and arsenic and nitrate, and also potentially generate disinfectants in the process,” he said.

In 2014 the philanthropic arm of Tata Group – one of India’s largest multinational conglomerates employing over 600,000 people - awarded the project grant funding to build units to treat water supplies in remote Indian villages without any mains power.

eReuse – Increasing social equity, decreasing e-waste



Charlotte Wang and Rohan Pala – CVEN student –led project innovators

“I wanted the tools to create and change things”

Fourth year environmental engineering student Charlotte Wang has been volunteering her time and skills to assist others since high school. As a high achieving student (including a Duke of Edinburgh award) at Sydney Girls’ High School, Charlotte spent many outside school hours at Sydney Multicultural Community Services in Daceyville mentoring primary school children in Maths and English and running a support group.

Not surprisingly perhaps, as the daughter of two engineers (one geospatial, the other IT & software) Charlotte was good at mathematics from the start. But she was less interested in science. Nor was she interested in that traditional indicator of a budding engineer - Lego. ‘I preferred to read, rather than playing Lego,’ she says, ‘but I still wanted to know how things work!’

At high school she studied and excelled in history and legal studies. Her question as a child had always been a pretty big one. ‘Why is there injustice and what can we do about it?’ When it came to choosing a university course, Charlotte chose not to follow her social justice interest into the humanities or law, but into so-called ‘apolitical’ engineering.

‘Engineering has a direct impact on our lives, and engineers need to know how to design for people and to understand the impact of development on communities. I wanted in the end to study something not just to analyse or understand ideas, but to have the tools to create and change things.’

She didn’t wait for graduation to make her impact!

At UNSW Charlotte joined the local branch of ENACTUS – a social entrepreneurial group of students, academics and industry around the world. There she met a group of like -minded students and the idea of eReuse was born.

As Charlotte notes, computers are a highly useful tool, responsible for many advancements in our modern times, but also highly manufactured, toxic to our environment and difficult to recycle.

The students discovered that only 10% of the 4 million computers sold each year end up being recycled in Australia. The rest will become e-waste, the world’s fastest growing waste stream- discarded as landfill or exported to other countries, potentially causing severe



environmental and public health damage in developing nations.

At the same time, they learnt that almost 20% of Australians do not have access to a computer at home, and it is most likely those with lower incomes.

The aim of eReuse Inc. was to save UNSW computers from landfill –to refurbish and then recycle them for those people who lack access to computers– which have become almost a pre-requisite for full participatory citizenship in the contemporary world.

The School of Civil and Environmental Engineering was the first UNSW group to sign up for e-Reuse. Moreover, valuable funding and support for the development process was provided throughout 2016 by the Head of School Professor Stephen Foster and the School's Teaching and Learning Committee.

Rohan Pala, a civil engineering/commerce student, was looking for a way to engage more fully at university when he met Charlotte at a student expo stall and was encouraged by her to join the eReuse team. It wasn't long before he found himself also sharing the vision.

It was Rohan who steered the group through into incorporated status, and registered as not-for-profit organisation. The road was lengthy and complex – the day the email came through confirming that they were now officially not-for-profit was a memorable one. 'It was good' Rohan said' to feel that we had got through some previously uncharted territory – and were able now to reach further afield.'

In September 2016 an agreement to recycle and re-use UNSW IT equipment was signed between UNSW and ARC, UNSW's student union with the pilot program, developed by eReuse Inc., to be trialed as a UNSW program and implemented at a UNSW-wide level.

How it Works:

A weekly computer refurbishment workshop is held every Wednesday night at the UNSW Michael Crouch Innovation Centre, allowing students to gain hands on experience with computer hardware.

Orders for these computers are placed by caseworkers and social workers from Sydney's social service organisations, including Mission Australia, St Vincent de Paul, Core Community Services and Multicultural Communities – all organisations seeking to cultivate social justice, on principles of inclusion, participation, access and equity.

Computers that are not able to be refurbished are placed in a serviced e-waste recycling bin located in the Michael Crouch Innovation Centre. Participating organisations also ensure that the computers provided to them are recycled at the end of their life.

The successful development and launch of the e-Reuse project could well form a model for ongoing student-led courses and social enterprise projects at UNSW -which can also be applied to other universities and organisations.

It is an example of environmental engineering that involves social and technological solutions to deliver on all three pillars of sustainability: economic, social and environmental.

For more information, please visit eReuse Inc.'s website: <http://www.ereuseproject.org> and Facebook page: <http://www.facebook.com/ereuseproject>.

“We need to save our planetary home, and it is rural students who could make the difference.”



Environmental Engineering and Commerce student **Annabel Biddulph** (pictured above with the Dean of UNSW Engineering, Professor Mark Hoffman) comes from the tight knit cropping community of Cootamundra, about four and a half hours south west of Sydney.

Annabel attributes her interest in engineering to the inspiration of two “incredibly strong women” - her chemistry and maths teachers at Kinross Wolaroi School. It was also at school, through her careers advisor, that she first heard about UNSW’s Rural Engineering Scholarships.

She had her heart set on UNSW because of its reputation as the number one engineering university in Australia. Annabel was impressed by the range of engineering courses on offer and the research focus on renewable energies and sustainability.

“Also, as a woman in engineering I was attracted by the amount of support available for women through scholarships, societies and the women in engineering camp. I would like to become more involved in societies like this to further encourage women to pursue a career in engineering.”

Although Annabel knew there was a substantial gender gap in engineering, she was taken aback by the reality of it in the classroom.

“I had only ever heard the statistics, and known that it was something I wanted to help change,” she says. “It was an entirely different experience to walk into my first engineering lecture and actually see that the statistics

were correct. I remember arriving and feeling like the odd one out, and in a situation I had never encountered in my life.”

Annabel believes it is important to encourage rural participation in engineering degrees because rural students have a vested interest in their community’s issues, like water and resource allocation. She says if rural students returned to their communities they could collaborate on engineering projects with the local community with whom they already have a relationship. This would ensure the best outcomes for the community.

“I would like to come back to rural Australia at some point and help improve facilities that determine water allocation and implement new technologies for farmers that move away from fossil fuels and help support more sustainable agriculture,” she says.

Annabel’s wildest dream for the industry is to completely eradicate the need for fossil fuels.

Jack Griffiths was encouraged to apply for a scholarship to UNSW by his school careers advisor. Jack says the scholarship he won – a Faculty of Engineering Rural Scholarship - has changed the course of his life.

Jack grew up in Griffith, about 650km from Sydney and thought he would be there forever, until he went to boarding school in Sydney for Years 11 and 12. Jack wasn’t clear about what degree he wanted to do until the last term of Year 12, so it was hard for his parents and friends to offer support and encouragement to pursue Engineering.

"It was actually my Year 11 and 12 Engineering Studies teacher who piqued my interest in Engineering, as I never had the chance to study it back in Griffith," Jack says.

"He taught it in a way that made it seem fun and enjoyable. Had it not been for his input, I would never have really considered applying for Engineering, particularly Civil Engineering."

"In Year 12, we did subjects such as Aerospace and Civil. It involved quite a bit of mathematics, which I have



always loved, but also challenged me to think in new ways to solve difficult problems. It appealed to me as a subject on many different levels, and that was when I knew that Civil Engineering was the degree that I wanted to study at university. I applied for UNSW because I knew that it was the best."

Having begun this journey himself, Jack believes it is extremely important for the future of engineering - and the planet - to encourage participation from rural students.

"Among the 11% of Australians who live in rural areas, there is likely a handful of incredibly gifted and talented minds that could change the world with their ideas and ways of thinking - but they may never have the opportunity to discover their potential," Jack says.

"We live in an age where technology is advancing at an incredible rate, but with this, our planet is dying at an increasing rate. We need as many talented minds as we can find to help save our home, and it is these rural students who could make the difference. They must be encouraged to follow their passion".

Environmental Engineering student, **Danika Smith**, (pictured with Miles Campbell) believes the industry needs engineers from rural backgrounds not only because they are more likely to go back and work in rural areas where there are often skill shortages, but they can also offer a different perspective on the issues engineers face. She says rural areas may harbour great innovators that just need to be given a chance.

Danika, whose hometown is Bathurst, in Central West NSW, says that receiving the Campbell Family Rural Scholarship in Civil Engineering has been a game-changer. The Scholarship was established in 2001 by School alumnus Grahame Campbell (BE Civil '65, MEngSc '72 - Managing Director of CMPS&F from 1987 to 1995), who saw it as an opportunity to share his passion for both engineering and education. "My post graduate work at UNSW was pivotal to my success" he says, "When I had the opportunity I did not hesitate to donate the scholarship. Danika is a worthy recipient."

"Not having to worry about money has taken a lot of stress off my family and meant I could focus entirely on my subjects which has made me a better student, and will in turn my make me a better engineer," Danika says.

Danika first heard about the rural engineering scholarships through a UNSW stall at a tertiary education information day in Bathurst. She was impressed by the number of rural scholarships on offer - not only as an opportunity for herself, but also knowing that the university really valued what rural students had to offer.

While neither of her parents have STEM backgrounds, a family friend who is an engineer, was the first person to expose Danika to the possibility of studying engineering.

"She gave me a lot of support with the technical side of things while my English teacher encouraged me to push myself to get the marks for UNSW and helped me considerably with writing my scholarship application," Danika explains.

As a shy teenage girl trying to decide on a career path, and feeling slightly overwhelmed at the thought of entering a traditionally male dominated field, Danika says she was inspired by the UNSW Women in Engineering Development Program. It spurred her on, knowing there was concern and support for the welfare of female engineering students.

As for the future, like her scholarship sponsor, Danika is committed to giving back. "I'd love to move back to a rural area and do something in the water industry or in resource management, really making a difference in improving the environment in places that are often forgotten by government bodies in the city," she says.

"My big goal is to donate a scholarship like my own back to the university. This scholarship has made a huge difference for me and I'd love to share this with someone else. I'd also like to become a role model for future teenage girls who love maths and promote them to do engineering. I know there are plenty of girls who would make great engineers but they get turned off by the masculine stereotypes."

International collaboration to pressing waste issues in Asia



Waste is a global problem. It has no respect for international boundaries.

As Director of Environmental Engineering Studies at the School of Civil and Environmental Engineering, Stephen Moore knows more about this than most. Mr Moore investigates how substances flow through international economies with a view to making products and processes more sustainable. This means he documents the flow of raw products from mining, through the product cycle and then on to what happens to them at the end.

“Lead, for example, is found in lead-acid batteries for cars, as a stabiliser in PVC plastic materials, and as shielding around X-ray machines etc. We make an account on the production, use and disposal/recycling of the lead in these goods to calculate how much is flowing through the economy on a yearly basis and how much is coming out as waste into the environment, either as dispersive flows or as concentrated end-of-life goods,” Mr Moore explains.

His research led him to undertake some comparative studies between Australia and one of its major trading partners, Japan (a major importer of Australian substances like lead, zinc and cadmium), and then also to extend the system boundary beyond the national level to investigate the international trade-related effects.

With long-standing research collaborations with partners in Japan, and other countries in Asia, now going back 15 years, it is no surprise that Mr Moore was recently invited to contribute to the development of a United Nations Environment Program (UNEP) Holistic Waste Management graduate program.

“The program is targeted at middle management in local government in developing economies in South-east Asia and the Pacific, in particular the managers of water, waste water and waste management,” says Mr Moore.

“The waste management techniques often employed by these managers could be reasonably described as “primitive”. Similar in fact, to what it was in Australia in the 1950s or 60s! There is uncontrolled dumping, sometimes along creeks and rivers, and waste burn-offs with resulting problems of pollution and disease.”

The main objective of the new course, which should be up and running within three years, will be to provide training in waste collection, recycling, composting and landfill operation. It is being developed by a consortium of six core members which include the Asian Institute of Technology in Thailand; Griffith University in Australia; Kyoto University in Japan; TERI University in India; Tongji University in China; and UNSW Australia.



Planning sustainable infrastructure on Mer Island

Over two and a half thousand kilometres north of Sydney is a tiny island in the Torres Strait called Mer Island. The island has a community of 450 people who rely on diesel for electricity, desalination for water and import most of their food by barge from Cairns, eight hundred kilometres away. Their only waste disposal method is burning-off in a small open landfill.

The question posed to 70 students of the 2015 and 2016 fourth year Planning Sustainable Infrastructure course was: If you were an engineer, what would you do to improve the physical infrastructure to improve the quality of life on Mer Island?

The hands-on course saw UNSW student engineers engaging with Mer Islander people to deepen the dialogue about sustainable infrastructure and was devised by School of Civil and Environmental Engineering academics Stephen Moore and Professor Richard Stuetz, in association with Professor Martin Nakata from Nuri Gili (UNSW's Centre for Indigenous programs) and Doug Passi on the Island.

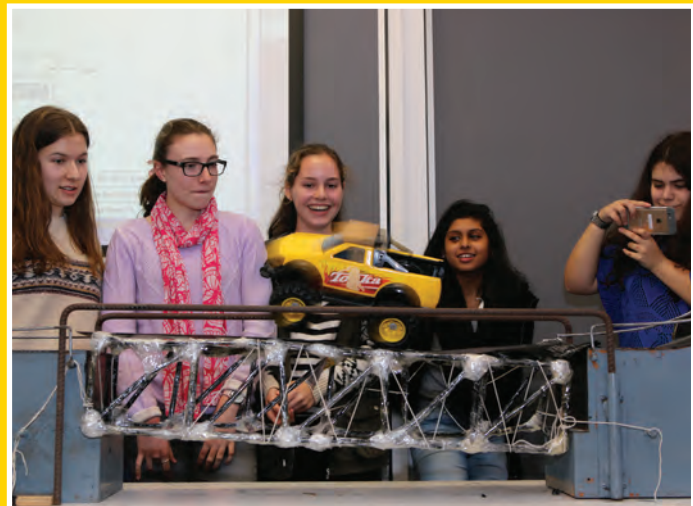
“The small scale meant students could easily see the direct impacts of these type of problems on both society and the economy, but we were also able to scale it up and say Mer Island is actually a microcosm of the whole of Australia,” says Mr Moore. “The course was tremendously valuable for everyone involved.”



A different perspective



Drs Lucy Marshall, Lauren Gardner, Kristen Splinter, Fiona Johnson.



Girls on CVEN Year 10 work experience week – design studio

For Dr Lucy Marshall, a civil engineering degree was initially something of a fallback option.

“I really didn’t know what I wanted to do when I finished high school, but I knew that I loved maths, and I thought engineering would get me a good job,” she says.

While she enjoyed her bachelor’s degree enough to pursue postgraduate study, it wasn’t until she started doing research that she really found her niche. Her passion? Terrestrial hydrology, with a focus on catchment responses to rainfall.

“I started seeing how I could use mathematics to apply to different sorts of engineered systems or natural systems, and then I realised oh, this is what I love; this is what I want to pursue,” says Dr Marshall, now an ARC Future Fellow in the Water Research Centre at UNSW Australia.

“When I was doing my undergraduate degree, if I’d looked 10 years into the future, I wouldn’t have thought that I’d be working in catchments. That’s pretty cool, that I can be doing problem-solving and applying mathematical concepts to something that might be considered outside of the classical civil engineering career path.”

As one of four female academics in the UNSW School of Civil and Environmental Engineering, Dr Marshall embodies a modern-day engineering story – a woman making great strides beyond the confines of a traditional engineering career.

It’s a story replicated in the trajectories of her colleagues, coastal engineer Dr Kristen Splinter, who studies sediment transport and coastal change due to storms; Dr Fiona Johnson, a hydrologist with a focus on rainfall and climate change; and Dr Lauren Gardner, a transport engineer who models the risk of disease spread as a result of human mobility.

But as working engineers, all four women are still exceptions in the largely male-dominated world of engineering. According to Engineers Australia, only 11.8 per cent of professional engineers were women as of the 2011 census, but the reasons behind such gender disparity remain difficult to untangle.

From misconceptions about what an engineering career actually involves and a lack of girls pursuing science, technology, engineering and maths (STEM) subjects in high school, to a dearth of female role models in the up-



UNSW WiE alumni and student network evening

per echelons of the profession, the engineering sector faces an ongoing battle to attract young women.

“I don’t think many people, when they’re leaving high school, really have a strong concept of what the reality of day-to-day work in their industry is actually like,” says Dr Johnson, who believes that a warped perception of engineering careers might be pushing young women away.

“The day-to-day roles of an engineer include doing calculations, drawing plans and maps, looking at all the constraints, getting community feedback, talking to government departments and other stateholders. Even if you’re working on a road project, the reality is that you’re not actually out there pouring the concrete.”

Getting girls to recognise that engineering offers opportunities beyond mining, chemicals and electronics is important too – data shows that female students gravitate towards disciplines such as environmental, civil and humanitarian engineering, rather than more traditional fields.

“There are copious niches within the engineering profession for people that have mathematical and sci-

ence-based skill sets, and an interest in applying them to real-world problems,” says Dr Gardner.

“Essentially engineers are just problem-solvers that can do critical thinking and solve problems quantitatively as well as qualitatively.”

The School is working hard to introduce female students to engineering as a career path from early in their schooling. Initiatives include sponsorship of a Year 10 work experience week, in which 60 students (a third of whom in 2016 were female) from NSW schools spend a week seeing civil and environmental engineering in action; a graduate ambassador program, where female engineering alumni are encouraged to promote engineering careers to high school girls; and full support for the UNSW Faculty of Engineering’s Women in Engineering (WiE) Development program and the WiE student society. Indeed, in 2016 a majority of participants in the UNSW Women In Engineering Society’s Industry Mentoring Program were students or alumni from the school, from both civil and environmental disciplines. We are especially grateful to our alumni, both men and women, who have returned to participate as mentors.

All these endeavours are already bearing fruit. Nearly 22 per cent of students within the School of Civil and Environmental Engineering are female, compared to a national average of 16 per cent. Like the Faculty, the School is committed to aiming for a 30 per cent female undergraduate participation rate by 2020.

There’s still a long way to go, but these numbers signal a shift in the right direction.

“High school teachers, mentors and guidance counsellors need to encourage females to consider these historically more male-dominated fields,” Dr Splinter says.

“But I think we are slowly making changes, and these are coming from the next generation through supportive mentors and peer acceptance. At Open Day, there were prospective female students waiting to talk to us over our male colleagues. I hope that when they see us, they realise that engineering is a good option for them.”

Global water quality advisor



Is there anything more vital to the health of our planet and its people than the safe and consistent supply of water? Communities across the world suffer terribly from lack of access to clean, pure water; suffering that ranges from the spread of diseases, to failed husbandry, to the despair experienced by drought stricken Australian farmers.

Water is elemental, yet it can elude us, disappearing into the air and the oceans. Humanity has been cavalier and wasteful. By 2025, half of the world's population will be living in water-stressed areas. Maybe it is time to change the way we think about and use water.

Associate Professor Stuart Khan is at the forefront of this change. In 2014 he was appointed to the Water Quality and Health Technical Advisory Group (WQH), reporting to the World Health Organisation (WHO). As the international authority on water quality, WHO leads global efforts, advising governments on the development of health-based targets and regulations.

Through this appointment, Stuart Khan has become part of a dynamic global community. All of its members are united in seeking to transform the lives of those who suffer from unsafe or unstable water supply. In 2020 WHO will publish the most comprehensive guidelines ever created for water quality hazard identification and risk management, tackling issues on a global scale.

Stuart has been providing expertise to the highest level of Australian government for many years as part of

his pro bono work for the National Health and Medical Research Council Water Quality Advisory Committee. Originally, he was only one of two academics appointed to this committee and Stuart sees it as a solemn responsibility to use his expertise for the greatest good. Now his influence is spreading.

Stuart moved across to engineering from science because he was attracted to the practical and creative nature of the field. He saw environmental engineering as a way to "bring immediate practical benefit to human societies". The Technical University of Munich recognised Stuart's abilities by appointing him as the Hans Fischer Fellow. In this role he will work with the European Commission Water Framework Directive to improve the application of water quality guidelines there, with a focus on the remediation of trace chemical contamination from sewerage treatment plants.

This controversial re-use of water is a low cost, low energy answer to urban water management that is threatened by a prejudice; that 'ewwwhh' factor. Working with organisations like the European Commission and the World Health Organisation maximises Stuart Khan's chances of overcoming these prejudices and helping to realise a global water quality revolution.

The odyssey of geodesy

Professor Chris Rizos is passionate about promoting what he refers to as 'modern geodesy' and raising its profile on the global stage. Having provided over 20 years of unstinting service to some of the most prominent international geodetic organisations, Professor Rizos is perfectly placed to take us on a brief odyssey into modern geodesy:

What is modern geodesy?

Geodesy has traditionally been interested in working out the size and shape of the Earth, the rotation of the Earth in space and understanding the Earth's gravity field – all important applied science topics. With the emergence of the Space Age, however, we now have technologies that do these tasks at a level of accuracy far beyond what we need for surveying, so what started as an applied science related to surveying has now morphed into something much more: I call this modern geodesy.

Why is modern geodesy important?

Modern geodesy can be considered an Earth observation science. We can now measure not only coordinates, gravity and length-of-day, but we can also measure the variations with time of these (and many other quantities) so we now have to think in four dimensions. For example, anything that's related to a distortion in the shape of the Earth or a change in its gravity field can now be measured using geodetic techniques. GPS is our primary geodetic tool, but there are other satellite technologies as well.

As a service science, geodesy sits behind the other more visible sciences, providing tools and datasets that help geoscientists monitor global change (including natural and climate change), changes in the environment (to ice sheets and atmosphere etc) and geohazards (i.e. volcanos and earthquakes). The engineering side benefits too, but we apply the measurements and technologies in a more pragmatic way. Surveyors and civil engineers use modern geodesy on everything from small-scale building work to international mapping projects.



What kind of impact has UNSW had on the global geodesy world?

Considerable! Our impact has largely been through leadership roles in international and national associations going right back to the 1960s. Professor Peter Angus-Leppan, a former Head of the School of Surveying here at UNSW, was the first president of the International Association of Geodesy (IAG). I am the second president of the IAG with a UNSW connection. We've also had staff hold leadership positions on the International Society for Photogrammetry and Remote Sensing; the International GNSS Service; Multi-GNSS Asia; and many others.

How has international service enriched your career?

Working in international service goes well beyond the traditional academic profile – which tends to focus on publishing papers, raising grant income, and the like. It's given me a lot of pleasure because I've been able to look at, and even influence, the 'big picture'. It's very satisfying to be part of the evolution of geodesy, not just in the theoretical sense, but actually seeing cool space technology being incorporated into real measurement systems which have considerable global impact.

CevSoc – Building Community



We may be excused for thinking that, in the past, undergraduate student societies were mere excuses for organised letting-off-steam and rites of over indulgence. In Australian engineering departments these societies may have looked like bastions of blokes, barbeques and beer.

How far we have come!

Today CevSoc, the student society for the School of Civil and Environmental Engineering is a progressive community of students committed to inclusion, altruism and equity, concerned with the health and growth of their industry and eager to enlarge professional opportunities for their members.

During 2016 President George Chard and Vice-President Alex Warren have made it one of their primary aims to include more of the CVEN international students, who comprise twenty-five percent of the CVEN student cohort. International Students Night, was eight months in the planning and was attended by ninety international

students. These current undergraduates, studying in a second language met with international alumni who had successfully negotiated university and found work in Australia or internationally. Since that night at least fifty percent of the attendees have re-engaged with Cevsoc in an unprecedented communion of local and international students.

This student society has addressed issues of language and culture with a mature and contemporary sensibility that could be the envy of all on-campus organisations. Language difficulties are discussed openly and dealt with kindly. All major social media posts are translated into Cantonese by a bi-lingual committee member. The social media platforms used are culturally relevant to international students. Questions by students struggling with English are answered sensitively, encouraging them to engage.

Running culturally appropriate events has meant overseas students feel welcomed. A hike from Spit Bridge to Manly, run in conjunction with Engineers Without Borders (EWB), means that visiting students are guided

“As an international student at UNSW, it was a daunting and nerve-wrecking experience walking into UNSW not knowing anybody. CEVSOC was one of the first student societies I joined and being a part of CEVSOC is one of the best decisions I have made. The huge variety of events, (especially the First Year Camp) have helped me meet so many new people and make many new friends within my university cohort. CEVSOC has truly made my university experience worthwhile and has helped me feel at home at UNSW.”

Varsha Sivagurunathan, 2nd Year Environmental Engineering Student (International Student)

“Through the different social and technical events held by CEVSOC, I have had the opportunity to become more involved in the student and professional community within civil engineering. In particular, CEVSOC Third year camp was an amazing opportunity to connect and reconnect with other civil and environmental students, whilst having the opportunity to meet experienced industry professionals. The camp provided a relaxed, social networking environment, a stark contrast to the traditional networking events held at university.”

Aurelia Israel, 3rd Year Civil Engineering/ Environmental Engineering Student (International Student)

through the local environment, a lack felt by previous international students.

The global consulting firm Advisian is a CVEN School sponsor and has joined with CevSoc to create the inaugural Sustainability Challenge, where teams of students design a project that addresses a real world environmental challenge. This competition has been very appealing to international students and allows them the opportunity to network with professionals by letting their work and creativity do the talking.

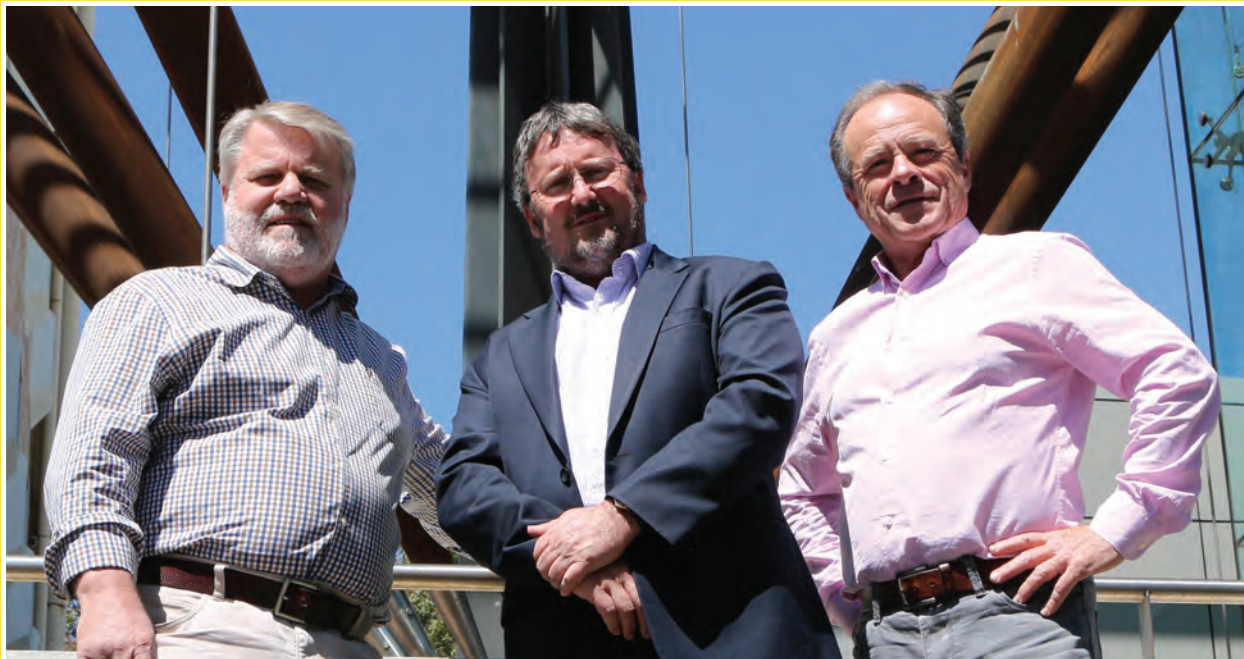
CevSoc currently has three international students as active committee members and hopes to reach a quota of twenty-five percent in the near future. Gender quota systems have been successfully in place for several years. Promisingly, it is the youngest of our university community that is providing some of its most affirmative action.

CevSoc First Year Camps are designed to gather new students together to help prepare them for university life, creating a community from a disparate group of fledgling engineers. The inaugural Third Year Camp is

designed to help those about to graduate to the real world of work. Design challenges, guest talks, physical games and social activities place students side by side with post-graduates, alumni and professionals, networking in a more equitable setting than the awkward ‘drinks and canapés’ in professional offices. Here, past CevSoc members, now professionals in the field, give freely of their time.

A community of past and present, of local and international, of men and women is being consciously created by the new wave of young engineers, committed to the environment, inspired by altruistic motives and committed to an inclusive policy that will help extend the tendrils of the School of Civil & Environmental Engineering across the globe.

Raising the standards



Professors Ian Gilbert, Stephen Foster and Mark Bradford

Take a look around you. Unless you're deep in a forest, in the middle of the desert or adrift on the ocean, it's a pretty safe bet to say that construction standards have directly shaped the world you can see.

Construction standards are so woven into the physical fabric of society that most people give little thought to the incredible amount of research and expertise that goes into creating our man-made landscapes. But what exactly are they and why are they important?

"Construction standards define the level of public safety that we are mandated to achieve in our buildings and public infrastructure," says self-confessed concrete obsessive, Professor Stephen Foster. "The government sets the policy on how safe things should be, and then based on those settings we design a series of standards and codes for engineers to design by, to ensure that we meet the acceptable levels for public safety."

Professor Foster, who is Head of the School of Civil and Environmental Engineering (CVEN), is joined in his passion for concrete by long-time colleague Professor Ian Gilbert, and for a combined total of 60 years, they have profoundly influenced the development of one of the most crucial standards used by the Australian construction industry: The Australian Standard for Concrete Structures, or, as Professor Gilbert fondly refers to it, AS 3600.

"There are American and European construction standards, but we use the Australian standards and very significant parts of AS 3600 and its Commentary have been written by Steve and myself," says Professor Gilbert.

This means that the research conducted by Professors Foster and Gilbert has formed the basis of design for every concrete structure in Australia.

When you think about it, that's huge!

CVEN has played a large role in the development of a number of major Australian construction standards since the inception of the University in 1947. This includes: steel structures, concrete structures, timber structures, masonry, and the relative newcomer: composite structures. Today, the construction standards brains trust is still housed in the School, but has its own specialised research facility called the Centre for Infrastructure and Engineering Safety (CIES).

And 'brains trust' is about right for Professor Gilbert, who says the team at CIES (which has 15 academic staff, 25 full-time researchers and upwards of 60 PhD students) is without doubt the strongest group in the country. "We have at least four of the top 10 academics working in this area in our team. No other group comes close to this."

UNSW engineers are shaping the global construction industry through their engagement with Australian and international construction standards.

So, the next question on our lips is, how are these standards formed and how do they change over time?

Professor Gilbert, who has been involved in developing AS 3600 since the early 1980's, is only too happy to explain:

"Each standard has a committee that is charged with developing and progressing the standard. The AS 3600 Committee, for example, consists of major stakeholders including academics like Professor Foster and myself, but also representatives from concrete materials suppliers, steel reinforcement suppliers, the Institution of Engineers Australia and the Concrete Institute of Australia," he says.

"Since the early 1930s, when the first Australian concrete structure standard came out, the Committee has continually improved and revised the standard in light of new construction techniques, materials and design methodologies."

Although a large and important part of the CIES research team's work is in Australia, its influence over construction standards actually extends across the whole globe.

"I was engaged in the early 2000s to help develop

the fib Model Code for Concrete Structures 2010 and research conducted at UNSW was also used to inform that Code," says Professor Foster.

fib, which stands for Fédération internationale du béton or (in English) the International Federation for Structural Concrete, is a not-for-profit organisation that is responsible for developing the European construction standards and is formed by about 1000 members from 43 national member groups. The 2010 Model Code is the most comprehensive code on concrete structures ever published and Professor Foster is currently involved in the 2020 edition.

For his part, Professor Gilbert is involved in American concrete standards development through the American Concrete Institute; and other CIES heavyweights, Professors Mark Bradford and Brian Uy also have deep international responsibilities.

Professor Brian Uy, who is also the Director of CIES, is a significant contributor to international codes of practice in steel and composite construction through the American Institute of Steel Construction, the American Society of Civil Engineers and the International Association of Bridge and Structural Engineers. Professor Uy has also been the Chairman of the BD/32 Committee charged with the development of the new Australia/New Zealand Standard for Composite Structure, ASNZS 2327 which will be released in 2017.

Professor Bradford, who has himself attracted several million dollars of research funding from the Australian Research Council (ARC), is heavily involved in reviewing research applications for ARC's counterparts in Europe.

So, how does it feel to be part of a community of researchers, both past, present and future, whose work so profoundly shapes the world? Professor Foster is emphatic:

"I'm immensely proud of everything we continue to achieve. It's about that sense of achievement, of having created something new that positively impacts the economics of society and the community. That's exactly why we do what we do."

Shaping the debate



We can't coast along in the face of fierce storms

In an opinion piece for the Sydney Morning Herald in June 2016, Associate Professor Ron Cox, advised local governments to be proactive about understanding their coastal zones, so they can prepare and implement management programs that allow them to work with nature, rather than against it:

"NSW has only 15 identified hotspot areas along the coast: the total extent of hotspots is small – about 30km of a 1500km coast. However, the estimated value at risk is high. In high vulnerability areas, options include retreat, adapt and protect – or combinations of these."

Associate Professor Ron Cox, National Convenor of the Climate Change Adaptation Research Network for Settlements and Infrastructure

In June 2016, a series of 'superstorms' caused widespread property and infrastructure damage in coastal and inland NSW. One of the hardest hit areas was Collaroy-Narrabeen, where the beach retreated by about 40 metres and dramatically swallowed backyards.

During, and in the immediate aftermath of the storms, engineers from UNSW's Water Research Laboratory (WRL) played a central role in the intense media interest generated by these events - by first describing and interpreting the coastal impacts as they were unfolding, and then, as the wider impacts became apparent, by stepping in to a public advice role.

In this Q&A, Professor Ian Turner, Director of the WRL, takes us on a retrospective journey through the storms and shares his thoughts on how WRL is helping to shape the debate on a number of important national issues.

When the storm first hit Collaroy-Narrabeen, how was your team able to be on the scene first?

This storm actually came as no surprise to us at all. We are the custodians of a 40-year monitoring program along this stretch of coastline and have the ability to forecast whether or not a particular storm is going to have a significant impact.

We saw about five days out that this was probably going to be the largest storm of my career, so that's why we and our collaborators from UNSW Aviation and the NSW Office of Environment and Heritage were there with all our equipment, ready to monitor the pre- and post-storm condition of the coast, and quantify the impacts.

Is this forecasting ability something that could be applied elsewhere?

Definitely! We are already in discussions with a number of groups around Australia on building a coastal erosion forecasting capability; if we could see it coming at our site, there's no reason why we can't use the research that we've undertaken at Narrabeen-Collaroy to develop a generic coastal erosion forecasting system. These conversations are already well advanced, and I anticipate that they'll lead to a multi-year collaboration with a number of agencies.

The media interest in the research coming out of WRL, in June was considerable. Has this exposure led to any new opportunities or surprising requests for information?

Yes, to both. During and for some time after the storm, team members from WRL were inundated with media requests in Australia and beyond. Because the dramatic images coming out of Australia during the storm were



Cities face harsher, more concentrated rainfall

Dr Conrad Wasko and Professor Ashish Sharma made the news multiple times in 2016 with their research on how climate change not only intensifies storms, but draws them into narrower bands of more intense downpours:

“As global warming proceeds, storms are shrinking in space and in time. This means they are becoming more concentrated over a smaller area, and the rainfall is coming down more plentifully and with

more intensity over a shorter period of time.”

Dr Conrad Wasko, Postdoctoral Fellow, School of Civil and Environmental Engineering

“Most cities, worldwide, have older stormwater infrastructure designed to handle rainfall patterns of the past, but these are no longer sufficient. This is especially noticeable in urban centres because there is less soil to act as a dampener. Once the drainage capacity is overwhelmed, there is nowhere else for the water to go and increased flooding will be the result.”

Professor Ashish Sharma, ARC Future Fellow, School of Civil and Environmental Engineering

largely WRL's images taken from drones, it generated an enormous amount of interest in our research group, especially in Europe. I even found myself doing live interviews on BBC TV.

More locally, opportunities have included discussions about upgrading the sea wall at Narrabeen-Collaroy, and we're working with a number of other councils, assessing and quantifying damage at other locations along the coast. And then, outside the public glare, I've enjoyed some interesting engineering science communication opportunities like giving talks to high school students and interviews to journalism students.

Is taking on a public safety or advisory role an important direction you'd like WRL to take in the future?

Yes, it is. WRL, from its outset, has embraced both academic, fundamental research and applied research, addressing the harder water problems faced by governments and industry. Bridging those areas comes with an obligation to communicate those research outcomes and help inform public debate.

We learned a lot of lessons during the June storms, and have already initiated a new digital media strategy so we hope to be able to respond and communicate even better in the future.

You've previously called for the establishment of a National Coastline Observatory, and these storms have likely given this extra credence, but why is this kind of facility important?

Australia is a uniquely coastal nation with 85 per cent of the population living on the coast. Our highly variable climate, coupled with the projected impact of climate change, will inevitably result in increased hazards to coastal communities. We have hundreds of millions of dollars' worth of infrastructure right next to the ocean in these communities; not just homes, but cable lines, gas lines and sewers etc, so it's important that we come up with solutions to protect them.

A National Coastline Observatory, that is able to monitor strategic sites along the whole coastline, will be a critical part of helping protect these vulnerable coastal communities into the future.

Raising public awareness – Increasing community safety



Even slow-moving water packs a powerful punch

In June 2016, as a world first, engineers conducted a flood demonstration at the School of Civil & Environmental Engineering's Water Research Laboratory (WRL) with real, life-size cars.

As WRL Director Professor Ian Turner notes, "People die in their cars in floodwater with shocking frequency in Australia. WRL was already undertaking research into the stability of modern vehicles in floods, research led by WRL Principal Engineer and Manager Grantley Smith, in partnership with the NSW State Emergency Service, NSW Office of Environment and Heritage and insurer IAG."

"This research was just coming to fruition when the first June 2016 'super' storm hit NSW, so when another east coast low was due to hit a couple of weeks later, we felt a strong obligation to raise public awareness about the dangers of driving into floodwater and took the research straight to the media. The story was incredibly effective."

The resulting footage and interviews with WRL engineers featured on all seven national TV news networks and was covered in over 500 stories in online and print publications:

The tests themselves were a world first. Previous experiments to understand the force of floodwaters relied on using vehicle miniatures, rather than actual cars. Even the WRL engineers were surprised how easily cars weighing more than a tonne quickly became buoyant and unstable.

"What was surprising" says Grantley Smith, WRL Principal Engineer, "was just how little water it took to make

even a large vehicle unstable. They became vulnerable to moving floodwaters once the depth reached the floor of the vehicle. Even in low water depths and slow flow speeds, floodwaters had a powerful enough force to make them float away."

A small car, weighing 1.05 tonnes, was moved by water only 15 cm deep and with a flow speed of 1 metre/second (or 3.6 km/h). It completely floated away in 60 cm of water. Even a 2.5 tonne 4WD can be rendered unstable by floodwater 45cm high, and a similar flow speed of 1 metre/second. Once the water reaches 95 cm, the four-wheel drive can completely float, and needs almost zero force to move it by hand.

By contrast, an able-bodied adult is much more stable in flowing water than the 4WD vehicle.

"Part of the reason," explains Smith, "is that modern cars are made so airtight -for comfort reasons. They more easily float when encountering water. Another factor is that people underestimate the power of a swathe of moving water.

"People don't realise that even slow-moving water packs a powerful punch," said Smith. "Water is heavy: each cubic metre weighs about 1,000 kg."

WRL hopes the impact of their research will continue – as a public service warning. Beyond that initial media interest, notes Turner, "there have been some heavy rainfall events since June 2016. and each time in the media there has been a specific reference to our research and a reminder of the dangers of driving into floodwaters."

Joining the dots – Measuring the Zika virus risk

Using her engineering background to join some important cross-disciplinary dots, Dr Lauren Gardner joins with long-standing collaborator Sahotra Sarkar, a conservation biologist at the University of Texas in Austin, to address one of the most concerning public health issues of recent times: the spread of the Zika virus.

Zika, although usually asymptomatic in the people infected with it, is linked to the birth defect microcephaly, which causes babies to be born with under-developed brains. In February 2016, the spread of the virus, which has already infected millions of people in at least 45 countries, was declared an international health emergency by the World Health Organization.

Dr Gardner's role in the international research effort occupies a fascinating, and rather unique, position: she applies her engineering know-how on transport network modelling to epidemiology, or the spread of the disease.

"I come at the problem using a mathematical, data-driven approach, merging the data from transport systems with ecological models – which is where Professor Sarkar's research comes in, and outbreak data, to quantify the risk posed by Zika to different places in the world."

In research published in *The Lancet Infectious Diseases* in March 2016, Dr Gardner, Professor Sarkar and PhD student Nan Chen mapped how likely Zika is to spread in 100 cities worldwide under two scenarios, taking into account air travel, the set of affected regions, and the prevalence of the *Aedes* mosquito (a known vector, or carrier, of the virus) and the *Aedes albopictus* mosquito (a suspected vector of the virus).

"Since our research was published the *Aedes albopictus* mosquito has been proven capable of spreading Zika, which means the more serious scenario on our map is something we should worry about," says Dr Gardner. "This means Zika could show up in many parts of the world outside of the equatorial, tropical regions, which includes Australia."

"We hope to be able to accurately predict how infectious diseases will spread spatially," she says. "In terms of control, you can't realistically screen every passenger and plane arriving at every airport, so you have to be clever. You have to pick and choose where you're going to deploy personnel and resources to try and mitigate the problem. We are working to create robust models that will be available at the onset of an outbreak, so policy makers can act quickly and effectively."



For Zika and, indeed, any future pandemic, the importance of Dr Gardner and Professor Sarkar's modelling work cannot be overestimated and will continue to gain in relevance as more real-time travel and virus data becomes available in the public domain.

One of the world's most influential scientific minds



There are, perhaps, two characteristics that define Associate Professor Tommy Wiedmann's professional life. One is his belief in broad based collaboration across national boundaries. Another is his belief that the environment cannot be protected by missionary zeal but by action and example in the personal, regional and global spheres.

In 2012 Assoc. Professor Wiedmann won a coveted Thomson Reuters Citation and Innovation Award. This award identifies exceptional scientists by quantifying their citations and is regarded internationally as evidence of "sustained high impact" research. In 2015 he was listed as one of the 'World's Most Influential Scientific Minds' in a TR report which analyzed the number of cited research papers an academic published from 2003 to 2013.

Tommy Wiedmann has continued to refine his expertise and develop his international reputation in the innovative and holistic discipline of sustainability systems, including his role as technical advisor to Greenhouse Gas Protocol, the most widely used international accounting tool for world leaders to manage greenhouse gas emissions.

"Traditionally engineering has focused on technology, at times not considering the resources needed to produce it, but optimising technology alone is no longer enough". Wiedmann believes that to truly tackle global challenges, environmental engineering needs to site itself in a broader set of contexts: including ethical, legal, economic, political, cultural and social considerations.

In this new "endless field" engineers need to be flexible critical thinkers, willing to interface with a wide variety of stakeholders and disciplines to compose complex solutions. For example, water recycling technology, so vital in Australia, cannot be regarded as viable if the broader public continue to perceive recycled water as inferior or even offensive, as in the case of recycled sewerage. Likewise, renewable energy technologies are not successful if they are economically prohibitive; unavailable to a large part of the population. Sustainability systems, as a new field of engineering, seeks to include these social, political, economic and ethical variables in its mathematical and technological trajectories.

One of these new considerations is the identification of the invisible or 'outsourced' emissions as part of the drive toward a more accurate picture of consumption and its impacts. Currently Tommy is head of the Industrial Ecology Lab, working in collaboration with the Jolliet Lab from the University of Michigan. This 'lab' is creating ground breaking electronic infrastructure to identify the indirect environmental impacts created by extended and diffuse production and supply chains. These improved analytics will lead to improved modelling, helping to create a new era of sustainability research, deepening its accuracy, and hoping to increase environmental conscience with this increased flow of information.

Tommy's project within the national research and innovation hub, the Co-operative Research Centre for Low Carbon Living (CRCLCL) is the Integrated Carbon Metrics Project, conducted in partnership with international industry partners Bluescope, Aurecon and Aecom. This project will create an embodied data base of carbon life cycle and flow for specific building projects, precincts and regions. 3D modelling will heighten visualisation for specific precinct development, with case study precincts used to verify data in the hope that low carbon precincts will become a not too distant urban reality.

Such innovative and complex approaches to environmental policy, analysis and design are central concepts in the new CVEN post graduate program designed by Professor Wiedmann; Master of Engineering Science: Sustainable Systems.

Delivered for the first time in 2016 this program is providing exemplary education and thought leadership, attracting equal numbers of female and male students who are prepared to ask difficult questions of themselves and their industry.

In his attempts to increase ethical self-assessment, Professor Wiedmann always asks his students to first assess their own environmental footprint. It is only once we have truthfully seen ourselves can we ask the rest of the world to step more lightly on the planet.



Encouraging the young



An initiative of the School's Industry Advisory Committee, the UNSW Civil and Environmental Engineering Primary School Prize in Mathematics prize is now in its seventh year. The key objective of the Prize is to encourage a lifelong interest in mathematics, as one of the key requirements for a rewarding, fulfilling and socially useful engineering career.

Our aim is to raise the profile of mathematics and engineering at an early age - as statistics show that the fall away from higher level maths begins much earlier than Year 10. We wanted to find a way of communicating the practical value of maths and science to students prior to their high school years.

Able administered by external relations project coordinator Tricia Tesoriero, each prize is presented by staff or alumni of the School to the young student at the end of year presentation. Presenting the prize in person gives both students and parents a chance to meet a real life engineer. It also brings the university into the primary school arena, further connecting us with our community.

Selection criteria for the Prize is left up to the individual school but we emphasize applications and creativity as well as class projects and test results. Many primary schools prefer to share the prize of \$100 amongst several years - all students are issued with a special Certificate signed by the Head of School and the Chair of our Industry Advisory Committee.

Over eighty NSW schools participated in the 2016 Maths Prize, and prizes were given to 245 students, of whom, pleasingly, nearly one quarter were girls. It is important to us that girls receive such encouragement in their maths journey - as gender disparity in maths/science at HSC level has actually worsened since the 1980s.

Our congratulations go to all the young winners. We hope to see them at UNSW one day.



