If the shoe fits
Alumna Bel Teh mixes software solutions with high fashion
Improving the odds in the dating game

Plus
Ideas man Professor Bill Walsh
Research team’s space odyssey
Our latest solar world record
Creating the future

There’s been a lot of talk lately about the importance of STEM subjects – science, technology, engineering and mathematics – to our future prosperity. And it’s true – they are crucial. But no single discipline embodies all of them in the way engineering does.

Einstein once said: “Scientists investigate that which already is; engineers create that which has never been”. He was right, of course, as he so often has been. Relying on the basic discoveries of science, and relying on mathematics and critical thinking, engineers create things that have never existed before. They make technologies so useful and reliable that we come to rely on them every day, to the point that we take them for granted.

But what engineering students quickly discover is that the discipline also opens the door to a multitude of rewarding careers. What’s more, it makes them as future-proof as possible.

Why? Because engineering doesn’t teach you skills that are necessarily tied down to any particular industry or job: it teaches you how to think. It teaches you to solve problems using your mind; to approach challenges based on evidence and thoughtful analysis; and to work in teams to come up with creative solutions. These skills are used by engineers working in fields as diverse as shoe design, financial markets and criminology – as well as the multitude of creative and innovative roles within traditional areas of engineering.

It’s estimated that, due to automation and artificial intelligence, 47% of jobs today will not exist in 15 years’ time. The only insurance you have against this enormous upheaval is to train your mind – give it thinking skills that are adaptable to any industry. Skills that the economy today is crying out for, and the jobs of the future will demand. Engineers will be at the nexus of creating that future, because what they do underpins all technological advances and human progress itself.

Professor Mark Hoffman
Dean of UNSW Engineering

UNSW’s student-led group CREATE was the talk of Vivid Sydney for the second straight year after designing a colourful, interactive Mondrian Cube.

CREATE’s aim is to take classical concepts and transform them into modern-day art using engineering skills. Last year, the group turned arcade game Pac-Man into a giant robot. This year, CREATE took inspiration from Pieter Mondrian and the De Stijl art movement and designed a two-metre-tall Mondrian Cube lit with interactive panels.

“Visitors could change the illuminated colours by touching a panel,” says CREATE president Alexander Yellachich. Piezoelectric sensors controlled more than 250 metres of LED strip routed with 600 metres of electrical cable. As every metre of strip had 30 LEDs, the cube contained an impressive 7500 lights.

The project was led by UNSW engineering students Chris Ho (Civil/Architecture), Yunzhen Zhang (Electrical), Scott Fraser and Daniel Castillo (Mechatronics) and Laura González Llamazares (Aerospace), plus Jessica Tanzil from Industrial Design. They were backed by 15 volunteers.
A new solar cell configuration developed by UNSW engineers has pushed sunlight-to-electricity conversion efficiency to 4.5% – establishing a new world record for unfocused sunlight.

Dr Mark Keevers and Professor Martin Green of UNSW’s Australian Centre for Advanced Photovoltaics set the record using a 28-square-centimetre four-junction mini-module embedded in a prism that extracts the maximum energy from sunlight. It does this by splitting the incoming rays into four bands, using a hybrid four-junction receiver to squeeze even more electricity from each beam of sunlight.

“This level of efficiency had not been expected for many years”
— Professor Martin Green

The result, confirmed by the US National Renewable Energy Laboratory, is almost 44% better than the previous record set by US-based Alta Devices, which achieved 24% efficiency, but over a larger surface area of 800 square centimetres.

“This encouraging result shows that there are still advances to come in photovoltaics research to make solar cells even more efficient,” Keevers said. “Extracting more energy from every beam of sunlight is critical to reducing the cost of electricity generated by solar cells as it lowers the investment needed, and delivers payback faster.”

The same UNSW team set a world record in 2014 when it achieved an electricity conversion rate of over 40% by using mirrors to concentrate the light – a technique known as concentrator photovoltaics (CPV) – before splitting out various wavelengths. The new result was achieved using normal sunlight with no concentrators.

“What’s remarkable is that this level of efficiency had not been expected for many years,” said Green, who has led the field for much of his 40 years at UNSW. He said Australia’s research in photovoltaics has already generated flow-on benefits of more than $8 billion to the country.

Cost and manufacturing restraints mean multi-junction solar cells of this type are unlikely to find their way onto the rooftops of homes and offices. The spectrum-splitting approach is perfect for solar towers – such as those used by Australian photovoltaics technology developer RayGen – which use mirrors to concentrate sunlight that is converted directly into electricity.

The research was funded by the Australian Renewable Energy Agency, UNSW (in partnership with RayGen), photovoltaics module manufacturer Trina Solar and the US National Renewable Energy Laboratory.
Perfect fit

Alumna Bel Teh has found a niche that brings together high fashion and engineering.

**Working as a software engineer** for custom shoe design start-up Shoes of Prey, Bel Teh’s 3D rendering code allows customers to see exactly what their shoes will look like while they’re designing them online.

As well as bringing the customer-created shoes to life on the computer screen, Teh works on software solutions that have an impact on all areas of the business from the factory floor to the payments system. She has been working on a system that tracks the production progress and sends automated updates to customers when, for example, the shoes have been stitched or the soles have been attached. “Being able to see people experience and enjoy what you have created is very satisfying,” says Teh, who has been working for Shoes of Prey for five years after starting while still a UNSW student.

The company is based in Los Angeles – which Teh describes as “very glamorous” – and she also spends time in China, where she is learning how the shoes are made. Having the opportunity to live and work in a new country has been a job highlight. There are other perks, too: “I have a lot of shoes!”

Teh was attracted to engineering because she enjoyed maths, science and logic puzzles. She wanted to do work she loved while creating products that made an impact in the real world. “There are so many different industries you can enter as an engineer,” she says. “I don’t think I’ll ever get bored.”

“Without women to help fill the idea pool, society is missing out”

— Bel Teh

She says it’s important that more women get into engineering. “Engineering isn’t just about logical thinking, it’s also about innovating for the future. But without women to help fill the idea pool, society is missing out.”

Her next career goal is to get into more futuristic technology, such as robotics, electric cars and space-related projects, such as SpaceX. “I’d love to go to Mars,” she says, “as long as I could come back again!”
Professor Bill Walsh and his team are inventing the biomedical devices of the future.

Professor Bill Walsh is a dynamo. His energy and passion are so vibrant, it’s almost possible to see lightbulbs pop out of his head as he speaks.

Walsh is based at the extraordinary Surgical and Orthopaedic Research Laboratory at the UNSW Prince of Wales Clinical School. He speaks excitedly about the revolutionary spinal fusion device he has developed with co-inventor Dr Matthew Pelletier. Walsh established the lab in 1993 in a small room in the old stone Edmund Blacket Building at the Prince of Wales Hospital. It has evolved into an 800-square-metre space with 14 staff. With surgical theatres just 50 metres away, the lab is a perfect interface between engineering and medicine.

From here, the team has developed the Thru-Fuze™ device, which is designed to treat patients with chronic back pain and degenerative disc disease. Walsh says a biological hint triggered the discovery.

“In traditional spinal fusion, we’ve always relied on bone graft material to bridge two bones together,” he says. “The problem is that the bone has to work very hard to integrate through the graft material. One thing we noticed through the microscope is that if you perturb a bone it always gives a response – much like the bump you get when you hit your shin on something hard. Seeing this led us to think, ‘What would happen if, rather than having to grow from one bone to another, bone only has to grow into two sides of a bridge-like device?’”

They quickly proved the idea in concept. After filing the IP through UNSW Innovations (UNSW’s commercialisation company), Intellectual Ventures contributed $2.3 million to develop the technology. Walsh and Pelletier have since received almost $1.6 million from the NSW Department of Health’s Medical Devices Fund to take the device towards its first in-human trial. “We have a spine surgeon who’s collaborating with us and hopes to undertake surgery on patients in the next couple of months,” Walsh says.

The device has the potential to reduce the cost of surgery and improve the reliability of spinal fusion. With current surgical treatment, the bone must grow and form its own bridge, which can take 12 to 18 months or longer to complete. With the Thru-Fuze™ device, it’s successful at six weeks from a biomechanical perspective, and gets better with time.

“This proves that nature is the ultimate engineer and bone is the most elegant engineering base material,” Walsh says. “If we could copy bone, we’d be getting somewhere!”
e-commerce websites for the past 20 years and have changed the way people find products, information and, in the case of 5SV3, other people. Information-filtering technology “recommends” items that are likely to be of interest to the user, based on their profile and the opinions and habits of the whole community of users.

“The data is completely anonymised,” Bain says. “When we initially looked at the data we thought that one of the most important things would be what people write about themselves, but we found lots of problems with that. Then we explored other things that seemed to be important, like smoking or not smoking, wanting children or not, but when we started analysing that we found the data was incomplete, noisy and very hard to find consistent patterns.

“At that point we started to think about the interconnections—such as who sent whom a ‘kiss’—and this soon started to reveal some interesting patterns.”

Online dating has got a little bit easier thanks to a research collaboration between UNSW Computer Science and Engineering and Australia’s largest online dating site, RSVP.

“The problem we were looking at was huge,” says Dr Michael Bain, Senior Lecturer in UNSW’s Computer Science and Engineering. “Our task was to develop a recommender system that would rank enough potential ‘good dates’ in the top five or 10 so the user would be interested enough to take it to the next step.

“RSVP is the largest online dating site in Australia with a massive number of users. If you think that any user might be interested in getting to know any other user, and maybe taking things further, the number of person-to-person recommendations we could make is in the billions.”

Recommender systems have been popping up on e-commerce websites for the past 20 years and have changed the way people find products, information and, in the case of RSVP, other people. Information-filtering technology “recommends” items that are likely to be of interest to the user, based on their profile and the opinions and habits of the whole community of users.

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It started with a kiss. In RSVP, a “kiss” is like saying “hello” to someone else on the site. It’s an easy way to find out if interest is mutual before the next step is taken. “By fairly simple-to-define but quite computationally demanding properties, we learned a lot about people’s interactions from these ‘kisses’ just by looking at the connectivity over time and what people were doing in terms of their behaviour. So that became our focus.”

Analysing data at the “kiss” level had advantages for the research team because it was completely controlled. “Kisses” are predetermined messages – there is no personal information exchanged and interactions between users will either be reciprocated or not. The main advantage for RSVP is that if there is a successful “kiss” exchange – a free service – it is quite likely that the users will stay on the site so they can communicate freely.

The team developed several algorithms that were tested in a live online trial. “In our post-trial analysis we broke the information down by pretty much any variable we could measure,” Bain says. “Right through to things like diet, political beliefs, star sign, you name it. We found that the recommenders were not really changing the preferences of people in the sense that they are setting up potential matches between people who wouldn’t otherwise consider each other. What they seemed to be doing was help people find matches they could have found themselves via the search function, if only they had the time.”

The UNSW team presented their results to RSVP and, after some tweaks, undertook a second trial. “Obviously human interaction is an incredibly rich and complex thing, and what we’re looking at is a very simplified representation of that, but using the data we were able to build a picture and it did seem to work,” says Bain. “We published a number of research papers on our work and RSVP decided to implement one of our algorithms which, I believe, is still running on the site. This is a great outcome for our research.”

This research was conducted through the Cooperative Research Centre program, which is part of the Federal Government’s National Innovation and Science Agenda and aims to facilitate a technology transfer between academia and industry.
One looked brand new; the other worked but had a layer of sludge at the bottom. “Our first discovery was the units had survived very well during the earthquake and can obviously be used as an immediate response to a natural disaster, which is a great outcome,” he says. “The second discovery was in order to get the best out of the device, operators need to be able to access simple maintenance information much more easily. A paper manual is easily lost or destroyed.”

Le-Clech says an obvious next step is to design an app. “In a country where there is no drinkable running water and electricity only available five hours a day, it was incredible to see everyone watching YouTube on their mobile phones. With an app, anyone can learn about the units in a simple way, any time.”

Shaken and stirred

Associate Professor Pierre Le-Clech undertook a 10-day mission to earthquake-devastated Nepal for a special research project.

The Gorkha earthquake that struck Nepal in April 2015 measured 7.8 on the Richter Scale and killed more than 8000 people. Drawing on UNSW funds, Associate Professor Pierre Le-Clech visited the region in January 2016 to assess how Skyjuice water filtration systems were performing in the affected area.

Skyjuice is a not-for-profit organisation that specialises in supplying low-cost clean water solutions to developing countries and disaster zones. Its units are designed to be easy to use but once they are installed, it’s difficult to monitor their performance, Le-Clech says.

The recommended Skyjuice maintenance schedule is to shake the units daily (to clear dirt from the membrane) and clean them with commercial bleach occasionally. “They use an ultrafiltration membrane that works using gravity, so the feed tank just needs to be slightly higher than the membrane for the dirty water to be pushed through the fibres and clean water to be filtered as a result,” he says.

Le-Clech interviewed local users and assessed two units.

UNSW provides seed funding of up to $5000 to encourage staff to use their knowledge and skills to help rebuild communities affected by natural disasters.

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The Student Awards Gala Dinner, to be held on 16 September 2016 at Doltone House Hyde Park, will be a great opportunity to reunite with former classmates.

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Alumni now work across all parts of the industry and beyond – in Australia and around the world.

Petroleum Engineering is a growing and diverse community with students hailing from more than 30 countries. One in four is female. The School also has the largest number of full-time staff of any petroleum program in the country.

For more information on the Gala Dinner, contact event manager Marlene Glenister at petrolevents@unsw.edu.au
One small step

UNSW space engineers are taking their first foray into space on the international QB50 CubeSat mission.

Professor Andrew Dempster and his team at the Australian Centre for Space Engineering Research (ACSER) are thinking big. Dempster is convinced that now is the time to kick-start Australia’s commercial space future, and ACSER will take part in five space missions.

The first is the QB50 CubeSat Constellation Mission – a European Union project that will demonstrate the research benefits of deploying a constellation of small satellites. The UNSW team, led by Dr Joon Wayne Cheong, is working on two CubeSats – its own plus one developed with partners at the University of Sydney and the Australian National University. The University of Adelaide and University of South Australia are developing a third. “CubeSats are cheap, small and easy to send up,” Dempster says. “By having a fleet of them deployed at the same time, they can gather information in much the same way a large satellite could.”

CubeSats are miniaturised satellites that use off-the-shelf components for their electronics and structure. This has enabled universities, small companies and even space hobbyists to get a toehold in space research.

The mission is being coordinated by the von Karman Institute for Fluid Dynamics (VKI) in Belgium. About 50 CubeSats will be launched to collect scientific data in the lower thermosphere – a relatively unexplored part of the atmosphere about 200-380km above the Earth. “Normally when satellites come down that low, their mission is over and they just spin around and burn up,” Dempster says. “Because CubeSats are cheap, it doesn’t matter if they don’t live very long.”

University teams must send up one of three payloads specified by the VKI. The UNSW team is flying the Ion-Neutral Mass Spectrometer, which investigates the ion contents within the ionosphere. Individual teams can carry out their own experiments with any room left over. UNSW’s CubeSats will carry a specially designed *3S receiver, investigate self-repair and reconfigurable electronics and robust software and analyse the small satellite’s mechanical structure.

“Disruptive technology means Australia can develop a commercial space program”
— Professor Andrew Dempster

Dempster has further plans to grow Australia’s space future, including Delta-V – a space business accelerator and service company he wants to establish in Sydney. “There are huge opportunities out there, and this type of disruptive technology means Australia can develop a commercial space program with a relatively low level of investment,” he says.

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**QB50 CubeSat specifications**

COST OF EACH UNIT: $60,000 to $80,000
HOW MUCH THEY WEIGH: approximately 2kg
HOW BIG THEY ARE: 20x10x10cm
HOW LONG THEY CAN SURVIVE: up to 6 months
UNSW's Automated Composites Laboratory facility is a one-stop shop for research and industry.

Professor Gangadhara Prusty has a neat slogan for UNSW's new Automated Composites Laboratory. For researchers and industries that work with composite materials, it's the ideal place to "make, bake and break".

The $3.5 million facility is one of the most advanced educational centres of its kind. "As far as I know, UNSW is one of the very few universities in the world to have a composites manufacturing robot," says Prusty, who leads the Advanced Structure and Materials research priority group at UNSW's Mechanical and Manufacturing Engineering. "The four-metre arm reach robot is the centrepiece of our lab and typically seen in companies such as Boeing and NASA."

The automated tape-laying machine provides fast, precise and flexible composites fabrication. But it's not just the science fiction style robot that makes this lab so unusual. This one-stop shop has leading-edge fatigue testing, high velocity drop-impact instruments and a hydraulic isolated test bed that enable accurate and repeatable results.

"The facility can test large-scale metallic or composite structures under multi-axial loadings," Prusty says. "Plus we have the 'baking facility', an industrial-grade autoclave for even larger specimens. We can also test materials for strength – primarily tensile, compression, bending, torsion, fatigue and impact."

Housed within the Ainsworth Building complex, the integrated laboratory is a major learning centre for PhD students and will help industry develop groundbreaking composite technologies to solve real-world challenges. "We're currently working with the Defence Science and Technology Group to help develop super-efficient composite propellers for large ocean-faring vessels," Prusty says. "Using the novel properties of composites – bend and twist coupling – we can achieve unparalleled results."

World's first adaptive engineering course

UNSW Engineering, adaptive learning pioneer Smart Sparrow and FutureLearn have launched a free online course to improve outcomes in engineering education.

The world's first-ever open adaptive engineering course, "Through Engineers' Eyes: Engineering Mechanics by Experiment, Analysis and Design", is designed to unlock access to high-quality courses for learners of all backgrounds. It's the first engineering massive open online course (MOOC) to use adaptive technology.

Professor Gangadhara Prusty and Robin Ford, a retired associate professor, both from UNSW's Mechanical and Manufacturing Engineering, developed the course. Adaptive tutorials built on the Smart Sparrow platform engage students with real-life simulations and personalised course materials. It's hoped this approach will address the low completion rates in MOOCs and high failure rates in introductory engineering.

The course will be delivered through FutureLearn, the UK's first MOOC platform, and will be made available for all learners – students in introductory engineering programs, working adults looking to make a career shift into engineering or those interested in a real-world understanding of how things work.
Testing the waters

Global Water Institute director Professor Nicholas Schofield explains why UNSW’s newest initiative is so important.

Why was the Global Water Institute established?
One of the driving concepts behind the Institute has been to forge stronger connections between the water-related research expertise at UNSW so we can provide an integrated offering to solve the more complex issues that cut across a range of sectors and disciplines.

What can the Institute offer industry partners?
It has come to fruition at a most important time in human history when water issues are foremost on the minds of politicians, economists, industries, communities and within the science community. We’re very keen to listen and help identify the priorities of our clients, both nationally and internationally. We also want to bring innovations and new ideas into the marketplace.

What are the main themes you’re seeing?
In 2015, water was identified in the World Economic Forum as the number one global risk in terms of impact. In part that’s caused by increasing water scarcity in a number of regions, which creates mass migration and the foundation for wars, as we’re seeing in the Middle East. For me, one of the most alarming things is the rate of biodiversity loss across the planet, particularly aquatic species. This is exacerbated by climate change. Population growth is placing higher demand on water via increased irrigated agricultural production. There is also a suite of issues related to education and capacity building in many countries that have very little understanding of the complexities of water management.

How can the Institute address these issues?
We’re well positioned in various ways and to different degrees. We want to do that through partnerships and collaborations with players such as the United Nations, international development banks and the Australian Department of Foreign Affairs and Trade.

Why does water interest you?
I think one of the fascinating things about water is that it runs across so many sectors, whether it’s biodiversity, climate change, food production, renewable energy, public health or international development. Water clearly is essential for life but it underpins so many parts of the economy, so many parts of humanity, and it has an important role in spiritual and cultural contexts, too.

Civil and Environmental Engineering

Engineers win four UNSW Alumni Awards

Engineering graduates have won four of the 13 annual UNSW Alumni Awards, which celebrate outstanding achievements across arts and culture, science and technology, medicine and health, business and innovation, sports and sports administration.

A notable winner was Bob Cameron (BE ’74), who was awarded the Business and Innovation Award. Cameron, who was awarded an Order of Australia for distinguished service to the NSW mining industry, is founder and chairman (non-executive director) of Centennial Coal. Other engineering award winners were Airtasker entrepreneurs Tim Fung (BCom ’06) and Jonathan Lui (BE ’06), who were joint winners of the Young Alumni Award, Sunpower senior vice president of research development and deployment Dr Peter Cousins (BE ’01, PhD ’05), who won the Design, Engineering and Sustainability Award, and Emtek founder Dr Eddy Sariaatmadja (BE ’79, MEngSc ’81, HonDUniv ’14), who won the International Alumni Award.

The Dean of UNSW Engineering, Professor Mark Hoffman, said the Faculty was proud of its award recipients. “They have made a significant impact on society and business, demonstrating the values which we seek to instil in our students and community,” he said.
Throughout the video, Google Cards pop up to hint at the engineering behind everyday objects, like drinking water, a smartphone and makeup. From the Google Cards you can click through to a microsite to learn more about the featured objects and explore profiles of interesting engineers. These range from a medical imaging researcher to an International Space Station controller to a humanitarian engineer delivering clean water to communities in developing countries.

Engineers around the country are invited to take a photo of their work and post it to their favourite social media platform with the hashtag #madebyme to show the world how much of our everyday life exists thanks to an engineer.

UNSW, UQ, UWA, ANU and Monash, Melbourne, Wollongong and Adelaide universities were involved in the groundbreaking project.

Watch Nervo’s People Grinnin’, released by SONY Music on 15 July 2016, at madebyme.org.au

We needed to find a way to meet teenagers on their home ground — Dr Alex Bannigan

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Dr Alex Bannigan says an exciting interactive music video will help drum up support for gender diversity in engineering.

The latest video for Australian DJ act Nervo depicts young women creating androids in a futuristic lab. On glass touchscreens and in stylish protective eyewear, they “create” lifelike robot versions of Nervo, hair and makeup done and dressed in killer heels.

This official video for Nervo’s song, People Grinnin’, is part of a major national campaign aimed at improving gender diversity in engineering. In a unique collaboration led by UNSW between eight universities, Engineers Australia and advertising agency Whybin/TBWA, the “Made By Me” campaign endeavours to change the way young people, particularly girls, approach engineering. Nervo – twins Miriam and Olivia Nervo – were inspired to work on the campaign by their own experience as the only women in their class while studying sound engineering.

One of the biggest barriers to more women studying engineering is that they’re just not told about it. They don’t know what engineering is, or what engineers do. Those who think they know about engineering often have misconceptions about the kind of work involved – usually with a heavy emphasis on hard hats.

We needed to find a way to meet teenagers on their home ground and surprise them with an insight into engineering that would open their minds to its possibilities. This thought gave rise to the idea of producing an interactive music video, sprinkled with small nuggets of information to pique teenagers’ interest in engineering.