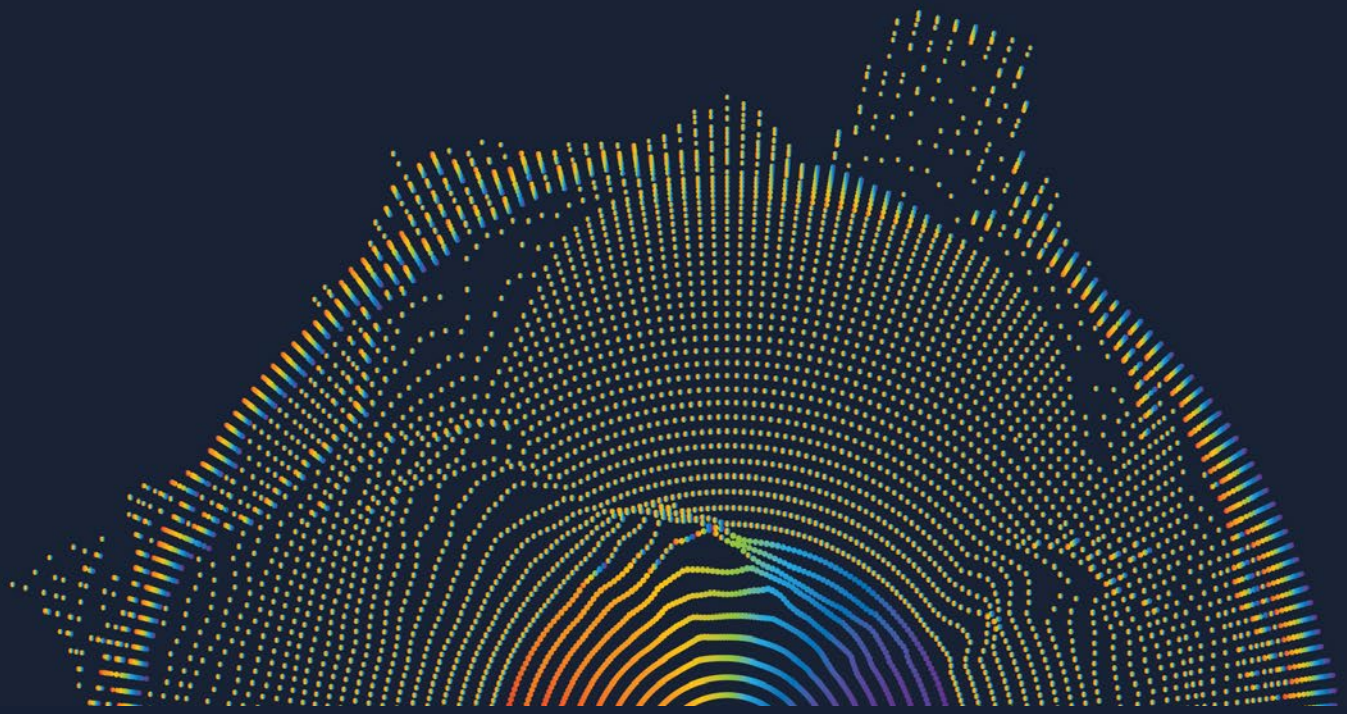
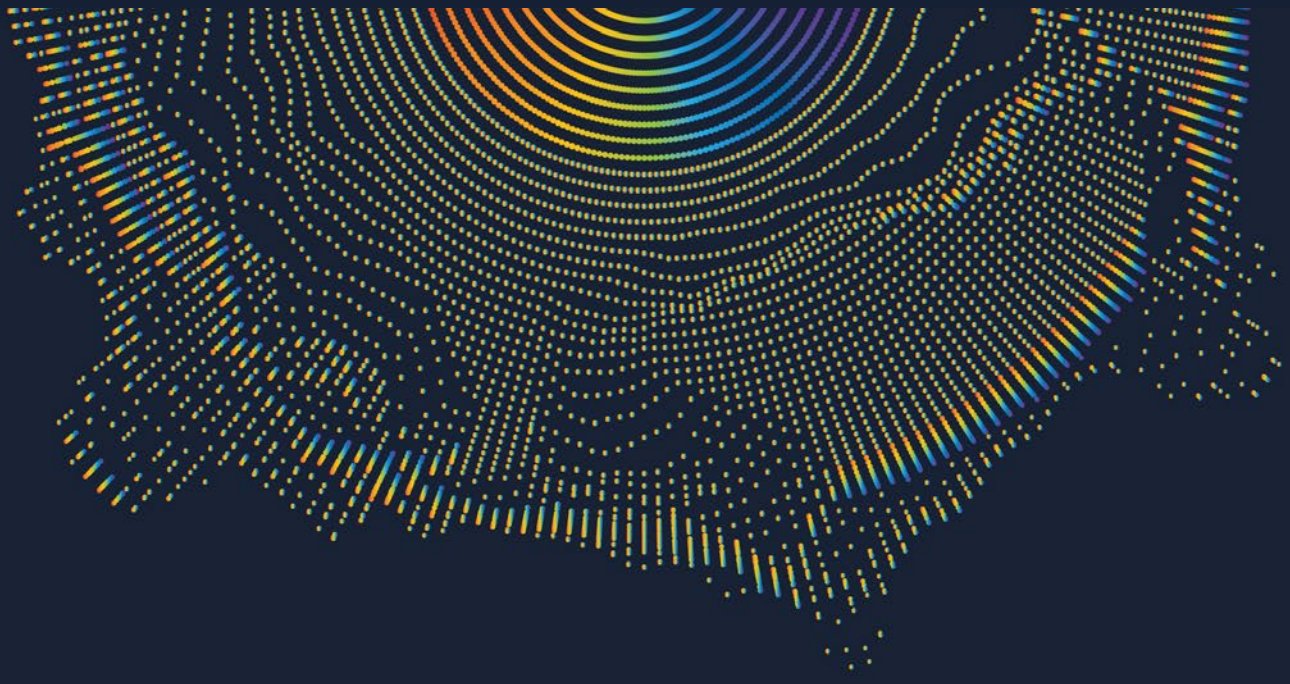
NUS | Engineering
National University of Singapore

ANNUAL REPORT 2016



NURTURING HOLISTIC ENGINEERS >>> IMPACTING LIVES



VISION

A leading Engineering School that innovates for a better future.

MISSION

To nurture Engineer-Leaders and to address global challenges through research, innovation, inspiration, and influence.

A WORD FROM THE DEAN

NUS Engineering has come a long way to be the vibrant Faculty we are today. As Singapore's first Engineering School, we have been training and nurturing engineers since 1955. Our graduates and staff have been instrumental in the nation's development, and are continuing to fulfil the country's needs and shape its future. The Faculty's achievements in 2016 reflect our unceasing commitment to nurture Engineer-Leaders, who will contribute to the nation's progress in the years ahead.

As with previous years, our faculty and students continued to strive for excellence in research, innovation and entrepreneurship in 2016. Six NUS Engineering colleagues were named among the world's most highly cited researchers in the 2016 Highly Cited Researchers report published by Clarivate Analytics (formerly the Intellectual Property & Science business of Thomson Reuters). Professors Lee Jim Yang, Liu Bin, Seeram Ramakrishna and Sam Ge, and Associate Professors Yan Shuicheng and Zhang Rui, each published a significant number of scientific papers that were among the top one per cent most cited in their subject field and year of publication.

Two other colleagues, Professor Lim Chwee Teck and Professor Andrew Nee, were recognised, together with NUS President Professor Tan Chorh Chuan, as among Asia's top 100 scientists by *Asian Scientist Magazine*. In addition, Professor James Goh and Professor Lim Chwee Teck were inducted into the prestigious College of Fellows of the American Institute for Medical and Biological Engineering, in recognition of their contributions in the area of Biomedical Engineering, while Professor Liu Bin was elected a Fellow of the Royal Society of Chemistry, and Assistant Professor John Ho was identified by the MIT Technology Review as one of the top ten young Innovators in Asia.

Faculty colleagues had also designed solutions that improved the quality of living, as well as inspired and changed lives. Professor Lim Chwee Teck, Professor Hong Minghui and Dr Luo Sha received ASEAN Outstanding Engineering Achievement Awards for their works, which were recognised as having made significant contributions to engineering and changing lives in ASEAN. Associate Professor Ho Ghim Wei and Assistant Professor Shao Huilin, winners of the 2016 *Singapore Women's Weekly* Great Women of Our Time Award (Science and Technology category) and L'Oreal Singapore for Women in Science National Fellowship 2016 (Physical and Engineering Science) respectively, are among the distinguished list of women who are changing the perception of engineering in Singapore. With their courage, determination and passion, they are inspiring more women to become engineers.

Our autonomous car, SCOT (Shared Computer Operated Transport), jointly developed with the Singapore-MIT Alliance for Research and Technology, started its run on the roads in 2015. In 2016, the team unveiled its self-driving scooter, designed for use in pedestrian environments and to navigate smaller and narrower pathways where larger vehicles cannot move around in. It has the potential to offer mobility to people who "cannot, should not, or prefer not to drive", including the elderly, disabled, or the very young.

At around 50kg, the scooter can travel at a speed of up to 6km/h, and has sensors built into it for location tracking purposes. It is able to indicate where it is, detect obstacles up to 2.5m in front and 10cm at the sides, and slow down or stop in response to them.

NUS Engineering also continued to do well in attracting funding to support and grow the Faculty's research. In 2016, the Faculty's total research income amounted to more than S$127 million, an approximately 34 per cent increase over the previous year's figure.

Among the new projects that received support were those funded by the National Research Foundation (NRF) for new innovations. These include the development of novel 3-D printing techniques for one-step fabrication of ceramic structures, innovative electronics beyond the rigid form, as well as a handheld photo-acoustic imaging probe and nanoparticle technology to offer real-time cellular resolution imaging for precise brain tumour surgery. Other new projects involve partnerships with the Energy Market Authority to develop cost-effective energy storage solutions for deployment in Singapore, the Infocomm Development Authority of Singapore to design a highly efficient hybrid cooling system for high ambient temperature data centre, and the Economic Development Board to establish the NUS 3-D printing Centre at NUS Engineering. 2016 also saw the Faculty continue to increase the impact of our research on industry. Together with Sembcorp Industries, we established a S$60 million Sembcorp-NUS Corporate Laboratory. Based in NUS and supported by the NRF, the Corporate Laboratory leverages on the complementary strengths of Sembcorp Industries and the Faculty to develop more efficient means of producing electricity from coal, cleaning industrial wastewater and converting incineration waste into materials for use in the construction industry. The Corporate Laboratory also provides an important platform for students and researchers to gain experience in industrial R&D, thereby linking NUS Engineering's research expertise to industry needs.

The Faculty's drive to create industry impact was also internationalised with the signing of a Memorandum of Understanding (MOU) with the Nanjing International Water Hub (NIWH), located on the Sino-Singapore Nanjing Eco Hi-tech Island. The MOU paves the way for NUS Engineering to explore a series of collaborative programmes to help Singapore's small and medium-sized enterprises (SMEs) bring new technologies and water treatment solutions into the Chinese and international markets. Specifically, NIWH and NUS Engineering's Centre for Water Research established the Water Technology Innovation Centre to collaborate with leading Chinese universities in research, and to commercialise research results with Sembcorp Industries and other industry partners, such as Singapore SMEs and water technology companies in China.

Our students have continued to push the boundaries of experiential learning, innovation and design in 2016. Many examples of their achievements are featured in this Report. An interesting and particularly noteworthy one is the development of *The Delta*. Taking up the challenge to build a 'fun' flying machine for the National Geographic Channel's new series "Machine Impossible", a team of eight students in our Innovation & Design-Centric Programme designed and built *The Delta*, an electric paraglider trike, over three months. Weighing just 49kg, *The Delta* is the lightest airborne passenger carrier in the world that can take off and land with wheels while carrying an adult pilot. It was featured in National Geographic Channel's first episode of Machine Impossible on 28 July 2016.

At the 50th anniversary celebration of the Institution of Engineers Singapore in 2016, Prime Minister Lee Hsien Loong said that Engineering will continue to be key to Singapore's future, as the country works towards becoming a smart nation, and overcoming its lack of resources. The value of Engineering is in the creation of a better Singapore – a cleaner, safer and more connected country, where people are empowered to lead meaningful and fulfilling lives, generate economic opportunities, and build a closer community within and beyond Singapore. Here at NUS Engineering, we continue to seek to inspire and nurture new generations of Engineer-Leaders, who will play critical roles in finding solutions to problems in clever and creative ways. They will become the link between scientific discoveries and the application of these new ideas in a world that is constantly changing. We believe that the Faculty provides the interdisciplinary and holistic education required to meet future challenges and achieve breakthroughs.

Our aspirations remain high; we will continue to press on and sustain the growth and progress of NUS Engineering, and play a pivotal role in Singapore's vision of becoming a Smart Nation. We have done well because of the tremendous support of our stakeholders, for whom we are most grateful.

PROFESSOR CHUA KEE CHAING
DEAN

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EDUCATION
RESEARCH
ENTERPRISE

NURTURING DIFFERENT CAREER PATHWAYS

NURTURING ENGINEER-LEADERS

FROM research and development to entrepreneurship, NUS Engineering revamped its curriculum to get undergraduates excited about engineering and the diverse career paths that engineers can pursue. The new curriculum aims to provide more hands-on work to give students a taste of what engineers do, as well as specialised pathways that nurture students with different aspirations and career goals.

Piloting the revamped curriculum, Electrical and Mechanical Engineering students took two modules on engineering principles and practice in the first year. They were shown the work of an engineered system such as a drone, dismantle the system to see how it was built, and then attempted to build one on their own.

Besides training students to be practising professional engineers, the Faculty opened up two specialisation pathways – in research and development, and design and innovation. The research pathway is suitable for students interested in a career in research and development in industry or a research institute, and provides opportunities to pursue postgraduate modules and acquire research experience through internships.

The innovation and design centric pathway, based on the Faculty's design-centric programme, is suited for students who are keen on developing new ideas and products, or exploring entrepreneurship opportunities in engineering. This multidisciplinary pathway helps students to acquire the knowledge, skills and tools to design user-oriented products.

NUS AMONG THE WORLD'S TOP UNIVERSITIES FOR ENGINEERING

NUS Engineering continues to be ranked high in the world by Quacquarelli Symonds (QS), Times Higher Education (THE) and Shanghai Ranking's Global Ranking of Academic Subjects.

For the first time, NUS Engineering was ranked 7th worldwide by THE. In the QS World University Rankings by Subject 2016, the Faculty's Civil & Environmental Engineering course was ranked 3rd, Chemical Engineering, 5th, and Electrical Engineering, 6th, while Mechanical Engineering and Materials Science & Engineering were ranked 8th. Among Asian universities, the Civil & Environmental, Chemical, Electrical and Mechanical Engineering programmes took top spot, with Materials Science & Engineering ranked second.

In the Shanghai Ranking, five out of seven NUS Engineering subjects, namely Energy Science & Engineering, Chemical Engineering, Civil Engineering, Materials Science & Engineering, and Electrical & Electronic Engineering, were ranked in the top 20.

POSTGRADUATE ENGINEERING STUDIES THE SWISS WAY

STARTING in 2016, students from NUS Engineering can pursue a postgraduate degree while learning the ropes of entrepreneurship at the latest NUS Overseas College (NOC) in Switzerland. The new NOC at the École Polytechnique Fédérale de Lausanne (EPFL) received its first batch of students in July 2016. NUS Engineering graduates will spend six months interning at design and engineering firms in Switzerland, while taking entrepreneurship-related courses at the university. EPFL will also send its students on an exchange programme to NUS, a feature unique to this NOC.

The tie-up with EPFL provides another avenue for students under the Faculty's Global Engineering Programme to be "immersed in an entrepreneurial environment", while deepening their technology knowledge.

OUTSTANDING SCIENTIFIC MINDS IN NUS ENGINEERING

SIX Faculty members were named among the world's most prominent researchers in the latest **Highly Cited Researchers 2016 report** published by Clarivate Analytics, formerly the Intellectual Property & Science business of Thomson Reuters. They are Professor Lee Jim Yang (Department of Chemical & Biomolecular Engineering), Professor Liu Bin (Department of Chemical & Biomolecular Engineering), Professor Seeram Ramakrishna (Department of Mechanical Engineering), Professor Ge Shuzhi, Sam (Department of Electrical & Computer Engineering), Associate Professor Yan Shuicheng (Department of Electrical & Computer Engineering), and Associate Professor Zhang Rui (Department of Electrical & Computer Engineering).

Professor Lim Chwee Teck (Department of Biomedical Engineering) and Professor Andrew Nee (Department of Mechanical Engineering) were listed among **Asia's Top 100 Scientists** by the *Asian Scientist Magazine* in January 2016. Professor Lim is noted for his outstanding research work in the field of medical and biological engineering, for which he was conferred the Vladimir K. Zworykin Award in 2015. Professor Nee, an expert in manufacturing engineering, was awarded the US Society of Manufacturing Engineers Gold Medal in 2014 for his lifelong contributions in the area.

Prof Lim, Prof Nee, as well as Adjunct Professor Tan Gee Paw, were featured in an article published by Asian Scientist in June 2016. Titled **"7 Scientists from Singapore to watch"**, they are among the seven Singaporean scientists, from either academia or industry, to be recognised for their contributions to Singapore's thriving research and development landscape in their respective fields, as well as for laying the groundwork for future breakthroughs and innovations.

Prof Lee Jim Yang

Prof Liu Bin

Prof Seeram Ramakrishna

Prof Ge Shuzhi, Sam

Assoc Prof Yan Shuicheng

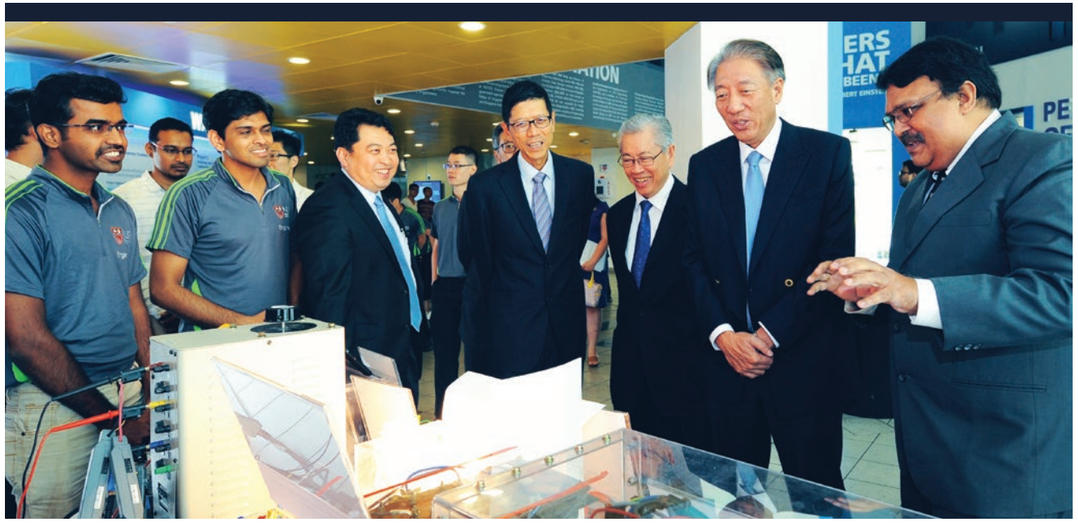
Assoc Prof Zhang Rui

SUSTAINABILITY THROUGH INDUSTRY PARTNERSHIPS

THE S$60 million **Sembcorp-NUS Corporate Laboratory**, established in partnership with Sembcorp Industries (Sembcorp), was launched on 20 April. Based at the Faculty, it is also supported by the National Research Foundation (NRF) under its Corporate Laboratory@University Scheme, which seeks to strengthen Singapore's innovation system by encouraging public-private research and development collaboration between universities and companies.

This synergistic industry-university partnership was created to pursue R&D work in three core areas – energy, water and waste-to-resource – to promote and improve environmental sustainability for Singapore. It aims to generate new scientific and engineering knowledge, and develop competitive and sustainable solutions for power generation, industrial wastewater treatment and water reuse, as well as transform waste into high value products such as ultra-light composites for modular construction.

The Corporate Laboratory harnesses the combined expertise of 45 researchers from NUS and 35 engineers from Sembcorp, as well as partner NUS Engineering research centres such as the Centre for Water Research and Centre for Advanced Materials Structures. It also provides an important platform for NUS students and researchers to gain experience in industrial R&D, and interact with engineers from Sembcorp.



DPM Teo Chee Hean (second from right) with Prof Panda (left of DPM Teo); Mr Wong Ngit Liong, former Chairman of NUS Board of Trustees (right of DPM Teo); NUS President Prof Tan Chorh Chuan (right of Mr Wong) and Prof Ng How Yong (right of Prof Tan) at the exhibition featuring capabilities of the Sembcorp-NUS Corporate Laboratory's three research areas: energy, water and waste-to-resource.

NUS Engineering's Centre for Water Research signed a Memorandum of Understanding (MOU) with the **Nanjing International Water Hub (NIWH)**, located at the Sino-Singapore Nanjing Eco Hi-tech Island in Nanjing, China, to jointly develop a research centre at NIWH.

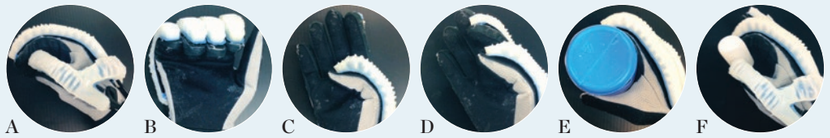
Named the Water Technology Innovation Centre, the research centre will enhance NUS' international visibility and reputation in research and development by supporting research collaboration with leading Chinese universities and commercialising projects with Sembcorp and other industry partners (e.g., Singapore SMEs and Chinese water technology companies) using water-related intellectual property generated by the Centre.

On 27 July 2016, NUS Engineering's Centre for Offshore Research & Engineering (CORE) signed an MOU with the **Korean Register of Shipping (KR)**, outlining a committed approach to working closely on the exchange of scientific, academic and technical information. It allows both parties to explore collaborative efforts in research activities, focusing on maritime noise and vibration, as well as other potential maritime and offshore engineering research topics. It also provides opportunities for attachments and internships for NUS Engineering students, and the organisation and participation in joint scientific activities, such as seminars and conferences.

As the world shifts to a natural gas-based economy, there is a pressing need to develop technologies to store natural gas efficiently and effectively on a large scale. NUS Engineering and **Lloyd's Register Global Technology Centre Pte Ltd** signed a research contract agreement to do this. Led by Associate Professor Praveen Linga, Department of Chemical & Biomolecular Engineering, a team of researchers from the NUS Centre for Energy Research & Technology (CERT) is developing a novel and cost-effective technology to store natural gas as Solidified Natural Gas (SNG) via clathrate hydrates. The technology is highly advantageous in being 'non-explosive', safe to handle, environmentally friendly and cost effective, while also offering a very compact mode of storage with high capacity. Moreover, the energy required for hydrate formation and storage can be provided by Liquefied Natural Gas (LNG) cold energy. The team intends to pursue the use of LNG cold energy in existing LNG re-gasification terminals to further offset the costs of SNG storage.

The project aims to develop a prototype for SNG technology, and demonstrate economic feasibility and storage stability over other conventional options, such as Compressed Natural Gas (CNG), in the context of Singapore's projected energy landscape. The innovation is in the reactor and process design, and the identification of a suitable promoter that can mitigate both the hydrate formation process and storage challenges.

This research project is funded in part under the Energy Innovation Research Programme (EIRP), which is administrated by the Energy Market Authority (EMA), and funded by the National Research Foundation (NRF). Lloyd's Register Global Technology Centre Pte Ltd, the industry collaborator, will provide significant cash and in-kind contributions to this project.



The EsoGlove promotes movements such as bending, extending, twisting and gripping.

ROBOTIC GLOVE RESTORES HAND MOBILITY

AN NUS Biomedical Engineering team, led by Assistant Professor Raye Yeow, designed and developed a robotic glove that can help stroke patients restore the use of their hands. Unlike conventional devices for hand rehabilitation, with rigid electromechanical components that are heavy and uncomfortable, the team's novel device – the EsoGlove – is light, made entirely of soft components and does not require complicated mechanical setups.

Acting on air pressure, embedded soft actuators apply forces distributed along the length of the finger to promote natural movements, such as bending, extending and twisting. Equipped with sensor technology that can detect and interpret muscle signals, the glove can assist patients in daily activities, such as holding a cup.

Said Asst Prof Yeow, who specialises in soft wearable robotics, "For patients to restore their hand functions, they need to go through rehabilitation programmes that involve repetitive tasks such as gripping and releasing objects. These exercises are often labour intensive and performed in clinical settings."

The team, which includes PhD candidate Yap Hong Kai and undergraduate student Benjamin Ang, worked with Dr Lim Jeong Hoon, Department of Medicine, to create the device. Hong Kai, who is with the NUS Graduate School for Integrative Sciences and Engineering, said, "As the soft actuators are made from non-ferromagnetic materials, they are suitable for use in functional magnetic resonance imaging studies. We hope that the robotic glove can contribute towards investigating the brain's activity in relation to motor performance during hand rehabilitation, and unravel the functional effects of soft rehabilitation robotics on brain stimulation."

Asst Prof Yeow and Hong Kai.

A six-month clinical trial on thirty NUS stroke patients started in February, to examine the glove's effectiveness in helping patients recover hand function. MRI was also used to study patients' brain during the therapy sessions. The team has filed a patent for the EsoGlove and plans to commercialise the device.

PERSONALISING MEDICINE WITH 3D-PRINTED PILLS

ASSISTANT Professor Soh Siow Long and PhD student Sun Yajuan from the Department of Chemical & Biomolecular Engineering developed a new method of tablet fabrication to make personalised medicine cheaper and easier.

The new method uses 3D-printing to make pills that can control the dosage and release rate of drugs to suit a patient's needs. Such personalised pills benefit patients requiring drug release in pulses, synchronised to the biological processes of their body.

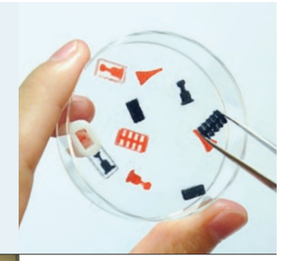
"For a long time, personalised tablets have been a mere concept, as they were far too complex or expensive to be realised. This tablet fabrication method is a game changer – it is technically simple, relatively inexpensive and versatile. It can be applied at individualised settings, where physicians can produce customised pills on the spot for patients, or in mass production settings by pharmaceutical companies," said Asst Prof Soh.

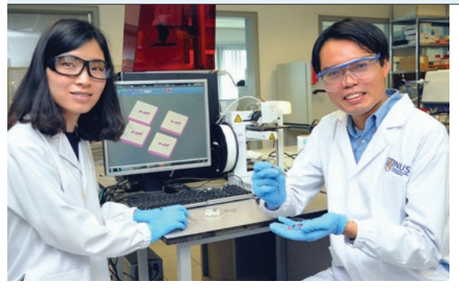
The new customised pill consists of three distinct components, including a polymer containing the drug in a specifically designed shape that determines the rate of release of the drug. For instance, a five-prong shape allows the drug to be released in five pulses over time. By adjusting the shape of the drug-containing polymer, it is possible to release drugs at any desired rate.

With this novel technology, a doctor only needs to draw the desired release profile in the computer software to generate a template specific to a patient's treatment needs, which can then be used to produce the desired pills using a 3D printer. The fabrication method can also be modified to include multiple types of drugs loaded within the same tablet, each customised to be released at different rates.

The team has filed a patent for the fabrication method and, besides commercial possibilities, is also exploring various combinations of materials for the polymer-based components in the tablet to cater to various types of drugs and illnesses, to increase the efficacy of this method.

The drug tablet printer designed by the NUS Engineering team consists of three distinct components: a casing, a non-drug-containing polymer, and a polymer containing the drug in a specially designed shape (shown in photo) that determines the rate of release of the drug. The shape of the drug-containing polymer can be adjusted to allow drug release at any desired rate.





Asst Prof Soh Siow Ling (right) and PhD student Sun Yajuan (left) from NUS Engineering have designed a novel system of tablet fabrication that can make customisable pills that release drugs with any desired release profile.

TREATING CANCER CELL BY CELL

RESEARCHERS from NUS Engineering and start-up Clearbridge mFluidics invented the world's first biochip that uses microfluidic flow to isolate selected tumour cells for single cell analysis, hence providing an accurate assessment of cancer type so as to enable targeted treatment.

The chip was developed by Professor Lim Chwee Teck, Department of Biomedical Engineering and co-founder of Clearbridge mFluidics, and his former PhD student, Dr Tan Swee Jin, who is now Technical Director of Clearbridge mFluidics. Measuring just 7.5cm by 2.5cm, it is able to specifically capture any of the diverse cells that make up a tumour for single cell analysis, and allows sensitive detection of critical low frequency mutations.

The cells are first obtained from liquid biopsy via blood draw – a process that is less invasive and painful – and can be done frequently compared to tumour biopsy. As cells enter the device, they are channelled via microfluidic dynamics into a single stream that leads them into various chambers. Each chamber captures one cell, allowing researchers to single out the cell they want to study, and eject it out of its chamber into a recovery port, where it is taken out for analysis. The biochip can process about 30,000 cells within an hour. By analysing every cancer cell present in a patient's blood sample, doctors will be able to pick out important information that can lead to more personalised treatment.

The researchers' breakthrough work has been published in Scientific Reports, paving the way for personalised cancer treatment. Besides treating cancer, single cell analysis could also be used in numerous clinical applications. The team is currently working on an improved version targeted for release in 2017.

From left: Clearbridge mFluidics' senior research officer and first author of the research Ms Trifanny Yeo, Dr Tan and Prof Lim with the microfluidic chip.

UNVEILING THE LATEST DRIVERLESS ELECTRIC SCOOTER

A team from NUS Engineering and the Singapore-MIT Alliance for Research and Technology (SMART) unveiled their latest autonomous, driverless vehicle this year – a four-wheel, self-driving electric scooter designed for use in pedestrian environments. Being able to navigate smaller and narrower pathways, the self-driving scooter helps overcome the mobility problems of the elderly and persons with disabilities.

"Mobility is not only outdoors," explained Associate Professor Marcelo Ang, Department of Mechanical Engineering, and co-investigator of the project. "You also want to be mobile in big complexes, like malls. So the concept of mobility is not only on the roads but the total mobility to get from point A to point B."

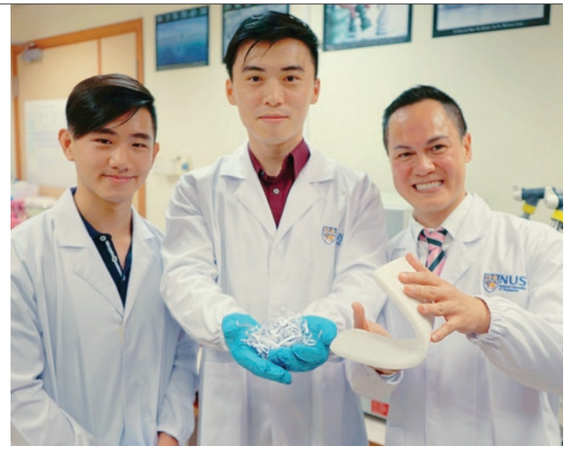
Weighing around 50kg, the electric scooter can travel up to a speed of 6km/h. As a safety measure, the scooter has sensors to detect obstacles up to 2.5m in front and 10cm at the sides, allowing it to slow down and come to a stop when approaching obstacles.

Assoc Prof Marcelo Ang demonstrating the use of the latest driverless electric scooter.

The project, supported by the National Research Foundation under its Campus for Research Excellence and Technological Enterprise programme, is currently in its trial stages.

TRANSFORMING PAPER WASTE INTO ECO-FRIENDLY, MULTI-USE CELLULOSE AEROGELS

RESEARCHERS from the Department of Mechanical Engineering created the world's first technology to convert paper waste into useful and environmentally friendly products known as "cellulose aerogels". Led by Assistant Professor Duong Hai Minh, the team has invented aerogels that are non-toxic, ultralight, flexible, extremely strong and water repellent, making them ideal for cleaning spills and used for heat insulation and packaging (replacing plastic-based bubble wraps). They can also be used as a coating for drugs to enable targeted delivery, and when compressed, can be used to plug gunshot or other wounds.



Asst Prof Duong Hai Minh (right) holding a sample of the novel cellulose aerogel which he jointly developed with his team members, Gu Bowen (centre) and Siah Jie Yang (left), who are both undergraduate students in the Department of Mechanical Engineering .

Coated with Trimethoxymethylsilane (MTMS), the aerogels are water repellent and capable of absorbing oil from water – up to 90 times their dry weight, making them up to four times more effective than commercial oil sorbents. Furthermore, they can be "squeezed" to recover over 99 per cent of the crude oil absorbed.

"As a heat insulation material, our novel cellulose aerogels offer a few added advantages. Their water repellent property allows them to be adaptable to both dry and rainy weather and their structure remains stable for about six months in a tropical climate. Being extremely strong, they increase building strength. In addition, the aerogels are lightweight and slim, resulting in slimmer walls, thus increasing building space," said Asst Prof Duong.

The team has filed a patent for their invention in the USA, China, India and Southeast Asia. In the meantime, the technology was licensed by the NUS Liaison Office, which is part of NUS Enterprise, to Bronxculture Pte Ltd in 2015 for commercialisation. The company intends to manufacture the cellulose aerogels and further expand their applications in three areas: insulating materials for packaging boxes, insulating layers for winter garments, and oil absorption materials.

ECO-FRIENDLY PACKAGING FILM DOUBLES SHELF LIFE OF PERISHABLE FOOD

PhD student Tan Yi Min (left) and Assoc Prof Thian Eng San with the result of their research.

ASSOCIATE Professor Thian Eng San and PhD student Tan Yi Min from NUS Mechanical Engineering created an eco-friendly food packaging material that doubles the shelf life of perishable food. Derived from crustacean shells, free from chemical additives and fortified with grapefruit seed extract (GFSE), the novel film has immense potential in food technology due to its biocompatibility, non-toxicity, short-term biodegradability and excellent film-forming capability.

The pair took three years to perfect the formulation of a novel composite film that not only prevents the growth of fungi and bacteria, but also has the mechanical strength and flexibility that are comparable to synthetic polyethylene film commonly used for food packaging. The film also effectively blocks ultraviolet light, slowing down food degradation due to oxidation and photochemical deterioration.

The film was developed with food safety and environmental sustainability in mind. Chitosan – a natural polymer extracted from the exoskeletons of crabs, prawns and lobsters – has inherent antimicrobial and antifungal properties, while GFSE is an antioxidant that possesses strong antiseptic, germicidal, antibacterial, fungicidal and antiviral properties. Laboratory experiments showed that the shelf life of bread samples packaged with chitosan-based GFSE composite films was two times longer than those packaged using synthetic packaging films.

"Increasing attention has been placed on the development of food packaging material with antimicrobial and antifungal properties, in order to improve food safety, extend shelf life and minimise the use of chemical preservatives. Consumers are also demanding that packaging materials be formulated from natural materials that are environmentally friendly and biodegradable while improving food preservation," said Assoc Prof Thian.

The project received support from the Singapore Institute of Manufacturing Technology, which will help link the researchers up with industry partners.

PRODUCING PURIFIED WATER FROM LNG COLD ENERGY

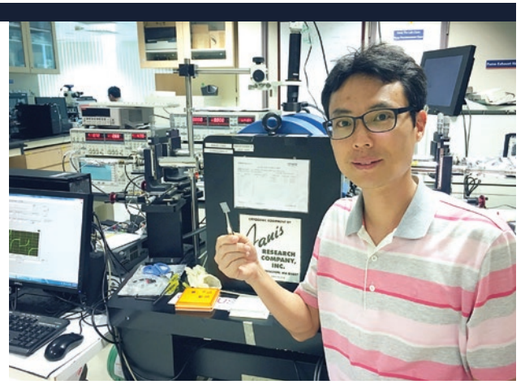
A team from the NUS Centre for Energy Research and Technology (CERT), led by Associate Professor Praveen Linga, Department of Chemical & Biomolecular Engineering, developed a prototype to produce purified water from seawater by harnessing the cold energy of Liquefied Natural Gas (LNG), using gas hydrate-based desalination (HBD) technology. The work was funded by the National Research Foundation (NRF) and industry partner Royal Dutch Shell.

The major challenges that have impeded the commercialisation of the HBD process are the slow kinetics of hydrate formation, crystal separation from concentrated brine solution, and cold energy required for the process.

"Our team has developed a new technique that employs a fixed porous bed made up of sand and water. When propane is employed as one of the hydrate formers in a gas mixture, hydrate crystals form above the silica sand bed. This results in both enhanced kinetics and a natural separation of crystals from the concentrated residual brine solution," explained Assoc Prof Linga.

In addressing the high energy required for a successful industrial scale application of the HBD process, Assoc Prof Linga and his team are the first to propose the innovative integration of the HBD process with LNG cold energy from the LNG regasification terminals. By using this cold energy to cool the HBD process, it is possible to drastically reduce the energy requirement and make it economically feasible. If the team's prototype can successfully prove the economic and technical feasibility of this process, it could mark a new milestone in developing innovative desalination technology.

Assoc Prof Praveen Linga (left) along with a team member, Abhishek Nambiar (right), with the experimental facility in the background.



Assoc Prof Yang Hyunsoo holding a piece of flexible material with magnetic memory devices transferred onto it.

WORLD'S FIRST FLEXIBLE HIGH PERFORMANCE MAGNETIC MEMORY CHIP

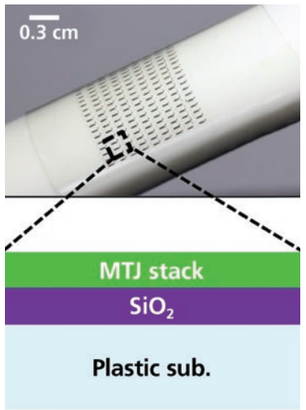
NUS Engineering researchers developed the world's first flexible high performance magnetic memory chip. How? By embedding a powerful magnetic chip on a flexible plastic material to obtain a malleable memory chip, which is a key component in the design and development of flexible and lightweight devices. Such devices have great potential in applications such as healthcare electronics, robotics, as well as military and aviation systems.

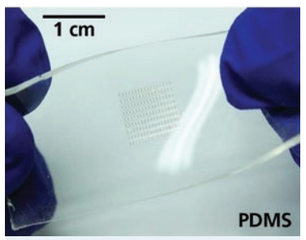
Said Assoc Prof Yang Hyunsoo, who is leading the team at the Department of Electrical & Computer Engineering, "Flexible electronics will become the norm in the near future, and all new electronic components should be compatible with flexible electronics. We are the first team to fabricate magnetic memory on a flexible surface, and this significant milestone gives us the impetus to further enhance the performance of flexible memory devices and contribute towards the flexible electronics revolution."

The novel invention has been engineered in collaboration with researchers from Yonsei University in Korea, Ghent University in Belgium, and the Institute for Materials Research and Engineering (IMRE). The device operates on magnetoresistive random access memory (MRAM), which uses a magnesium oxide (MgO)-based magnetic tunnel junction (MTJ) to store data.

MRAM outperforms conventional random access memory (RAM) in many aspects, including the ability to retain data after a power supply is cut off, high processing speed, and low power consumption.

The researchers were granted United States and South Korea patents for their technology. They are continuing to fine-tune the device and plan to apply their technique in various other electronic components, as well as explore further applications.



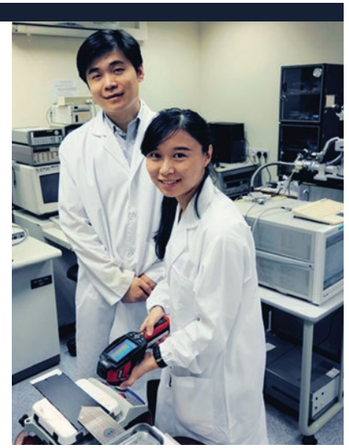


Top: Optical images of the magnetic memory devices after the transfer onto a flexible plastic platform with a schematic diagram of individual memory unit.

Bottom: The versatility of the platform transfer process. Optical images of magnetic memory devices transferred onto a flexible platform.

INNOVATIVE CAMOUFLAGE SHELL IS WORLD'S FIRST TO HIDE HEAT AND ELECTRICITY

INSPIRED by the humble chameleon, Assistant Professor Qiu Cheng Wei and his team at the Department of Electrical & Computer Engineering developed the world's first innovative camouflage shell that hides both thermal and electronic sensors simultaneously and effectively, without compromising performance.

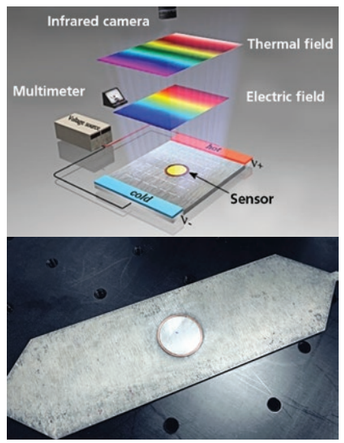


Asst Prof Qiu Cheng Wei (left) and PhD student Bai Xue (right) with their innovation.

Today, the available technologies that make sensors 'invisible' also render them ineffective, or they only allow the sensors to work in one specific environment – either thermal or electrical. The team has created an ideal 'invisible' sensor by covering it with a thin shell made of pure copper, designed to significantly reduce the perturbation of heat flux and electric current simultaneously. The thickness of the shell is manufactured based on detailed calculations to allow precise manipulation of external multi-physical fields to insulate the sensor. Hence, once the shell is wrapped around the sensor, the coated sensor becomes 'invisible' in both thermal and electric environments, but still continues to receive incoming signals from outside.

Asst Prof Qiu explains that the "camouflaging shell not only mimics surrounding thermal fields, but also electric fields, both at the same time. The object under camouflage becomes truly invisible as its shape and position cannot be detected in terms of both thermal and electric images. While remaining invisible, the object under camouflage can continue to probe the temperature and voltage in the environment that it is located."

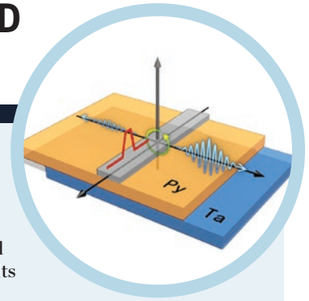
Able to protect the sensors from harsh environments and any surrounding distortion, the camouflaging shell could also potentially open up a new avenue for advanced sensing and security systems. The team is working on developing multifunctional invisible sensors that have instantaneous stealth ability, and is in talks with power companies and funding agencies to explore the potential of translation to fabrication.



Top: This is the first time that a sensor has been proven (theoretically and experimentally) to operate undetected in multi-physical fields simultaneously. The figure shows the schematic of multi-field operations for one physical design.

Bottom: A piece of metal with the shell coated material.

LEADING THE WAY IN FUTURE SPIN WAVE-BASED TECHNOLOGIES AND APPLICATIONS



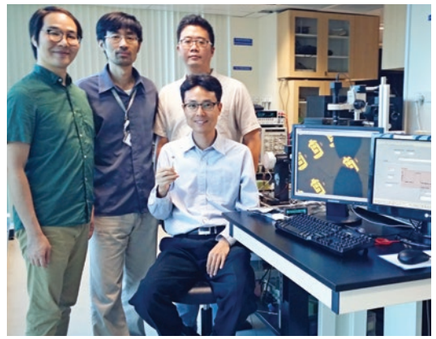
An electric pulse generates spin waves and their amplitudes, depending on the spread direction. Strong nonreciprocal spin wave emission is observed in Ta/Py bilayer systems, with out-of-plane magnetic fields which depend on the thickness of the Ta underlayer. The results can be applied to switch and logic applications.

A strong nonreciprocal (unidirectional) spread of signals, which controls the signal flowing to a desirable direction, is critical to any modern electronic logic circuits and fundamental applications, such as diodes, isolators, gyrators and circulators. This is extensively studied in the fields of microwave, acoustics and photonics.

However, nonreciprocity in spin waves has not been extensively researched, and is of great interest for both fundamental science and applications. Nonreciprocity in spin waves offers an extra knob to control the flow of waves for the technological fields of logic and switch applications. Spin waves could be used to develop innovative web-based computing technologies. Spin wave logic devices also have the potential to replace electronic logic devices. The suitability of nonreciprocal spin wave devices is restricted though, due to a small nonreciprocity parameter, especially with a typical magnet such as Permalloy (Py).

An Electrical & Computer Engineering team, led by Associate Professor Yang Hyunsoo, has overcome this challenge.

In collaboration with Japan's National Institute for Materials Science, and Korea University, the team demonstrated a giant nonreciprocal spin wave device using Ta/Py bilayer systems – which is important to guide the signal to spread only to a specific desired direction. The giant nonreciprocity depends on the thickness of the Ta underlayer, which can be increased up to 100 times larger than previous values.

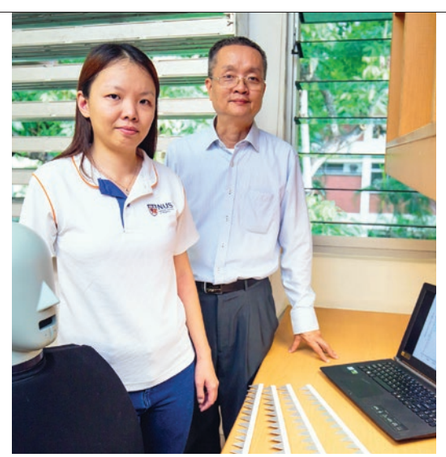


Assoc Prof Yang Hyunsoo (seated) holding a spin wave device. Standing behind him are his team members – from left: Dr Yoon Jungbum, Dr Kwon Jae Hyun, and Dr Lee Jong Min.

The findings are significant and critical to the development of future spin wave-based technologies and applications. The team can now measure the nonreciprocity parameter with electronic or optic techniques, as well as control the structure configuration of the ultrathin magnetic films to get higher nonreciprocity. The team is continuing to find even stronger nonreciprocal spin waves to excel the performance of photonics and microwaves.

INNOVATIVE SONIC CRYSTAL WINDOW MITIGATES NOISE

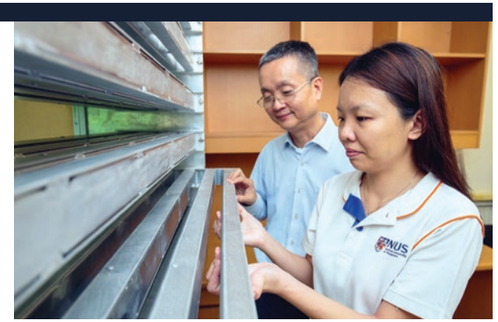
A groundbreaking window design, using sonic crystals to mitigate noise from traffic and construction, while allowing for natural daylight and ventilation, is the brainchild of Associate Professor Lee Heow Pueh and his team from the Department of Mechanical Engineering.



From left: Assoc Prof Lee Heow Pueh and Dr Lee Hsiao Mun from the Department of Mechanical Engineering, and their research team developed innovative window designs – sonic crystal window and jagged edge attachments – for noise mitigation, while allowing a good balance of natural daylight and ventilation.

Achieving the optimal design through computer simulations and field experiments, the team tested the prototype at NUS' Eusoff Hall, and discovered that the sonic crystal windows reduced traffic and construction noise by half. Even with the window open, the noise reduction was significant. By giving the louvres a saw-toothed edge, noise hitting the window could be further suppressed.

The project, a collaboration with the Building and Construction Authority (BCA) and the National Environment Agency (NEA), is test-bedding the windows in high-rise residential and office buildings at NUS' University Town. It is targeted to be completed by late 2017. The team is further refining the design to suit the various window types available in Singapore. A patent for the sonic crystal window has been filed, and opportunities to commercialise the innovative noise mitigation technologies are being explored.



The NUS Engineering research team is refining the design of the sonic crystal window to suit various window types in Singapore, while looking into developing a portable version of the sonic crystal window. The team is also exploring opportunities to commercialise their innovative noise mitigation technologies.

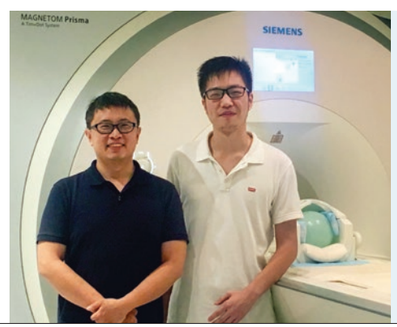
A NEW BAYESIAN MODEL FOR UNDERSTANDING ALZHEIMER'S DISEASE AND BRAIN DISORDERS

Alzheimer's disease affects ten per cent of the elderly population. It is a progressive disease that destroys memory and other mental functions.

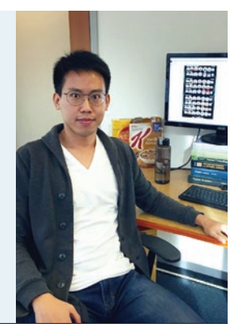
ALZHEIMER'S disease is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills, and eventually, the ability to carry out the simplest tasks. The symptom severity and brain atrophy (loss of brain cells) can vary widely across patients, complicating diagnosis, treatment and prevention.

To explain this variability, Assistant Professor Thomas Yeo, Department of Electrical & Computer Engineering, and students Xiuming Zhang and Nanbo Sun have developed a new mathematical modeling strategy, and applied it to magnetic resonance imaging scans of 188 Alzheimer's disease dementia participants and 190 at-risk non-dementia participants. The model reveals at least three brain atrophy patterns that explain variation in grey matter (brain cells) loss among Alzheimer's disease patients. Importantly, the atrophy patterns also explain variation in memory and executive function decline among dementia patients and at-risk non-dementia participants.

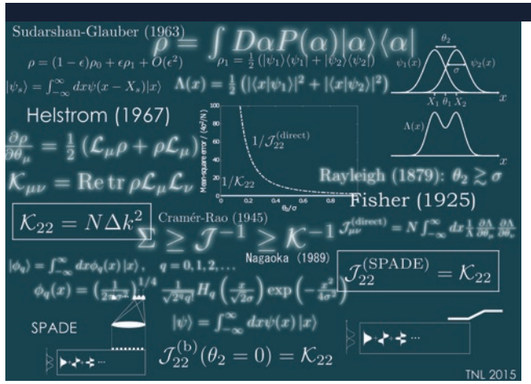
Asst Prof Yeo, who also holds joint appointments at the A*STAR-NUS Clinical Imaging Research Centre (CIRC), Singapore Institute for Neurotechnology and Memory Network Programme, said that "patients with predominant cortical atrophy are younger and diagnosed with Alzheimer's disease at an earlier age." He notes that "the framework can also be applied to explain symptom variability in other brain disorders, including autism and schizophrenia."



Asst Prof Thomas Yeo (left) and his students Nanbo Sun (right) and Xiuming Zhang (far right) developed and applied a new mathematical modeling strategy to magnetic resonance imaging scans of 188 Alzheimer's disease dementia participants and 190 at-risk non-dementia participants.



Xiuming Zhang performed this research as an NUS Engineering undergraduate student. He is currently pursuing his PhD studies at the Massachusetts Institute of Technology (MIT).



The mathematics that led to the breakthrough by Asst Prof Tsang Man Kei's team at NUS Engineering.

GROUNDBREAKING QUANTUM TECHNOLOGY ENHANCES RESOLUTION OF MICROSCOPES AND TELESCOPES

ASSISTANT Professor Tsang Man Kei and his research fellows, Dr Ranjith Nair and Dr Xiao Ming Lu, from the Department of Electrical & Computer Engineering, discovered new optical techniques that could measure the separation between two light sources more precisely in a groundbreaking discovery that could potentially improve the resolution of microscopes and telescopes by orders of magnitude.

Using a powerful theory called quantum metrology, their calculations reveal that the light emitted by two typical sources contains much more information about their separation than previously realised, and clever quantum optical methods can extract the full information, allowing the separation to be measured more accurately. Since the discovery was first announced in an online preprint in November 2015, no less than four independent groups from Singapore, Canada and Europe have performed experimental demonstrations of their theory. One of the groups is headed by Dr Alexander Ling, a principal investigator at the Centre for Quantum Technologies in Singapore.

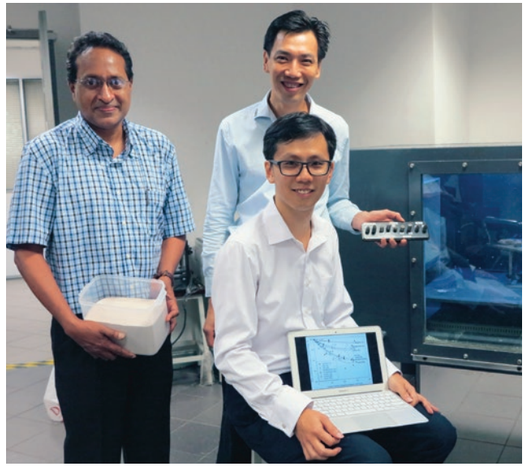
The team's seminal work was recently published in Physical Review X, a highly selective journal by the American Physical Society. These rapid developments suggest that applications of their ideas in both microscopy and astronomy should not be far away. Their next step is to explore how their techniques can be applied to the imaging of biological samples and to solve difficult problems in biology.

THE POWER OF SAND

WHILE sand has often been used in military fortifications, little was known about its energy absorption capabilities – until this year when a team of NUS Engineering researchers led by Assistant Professor Darren Chian Siau Chen from the Department of Civil & Environmental Engineering (CEE), proved that tiny grains of sand have the unique ability to potentially resist impact better than steel.

The team, which includes Associate Professor Vincent Tan (Department of Mechanical Engineering) and Adjunct Assistant Professor Anand Sarma (CEE), made the novel discovery after conducting tests where projectiles of various shapes and masses were fired at a wide range of velocities against a block of silica sand, one of the world's most common varieties of sand. They found that sand can absorb more than 85 per cent of the energy exerted against it. "Our findings show that sand holds a strong potential as a receiving layer of a composite material subjected to impact," said Asst Prof Chian.

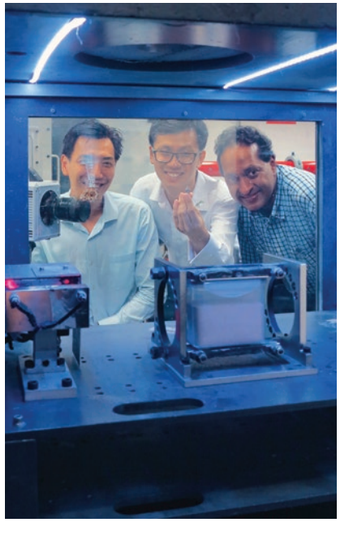
They also discovered that resistance offered by the sand block increases with the speed at which a projectile travels, and that the impact results in an extreme frictional force that could cause the projectile to break into pieces. The findings of the study may expand the applications of sand, which is presently used extensively in areas such as glass making, building construction and land reclamation.



From left: NUS Engineering researchers Adj Asst Prof Anand Sarma, Assoc Prof Vincent Tan and Asst Prof Darren Chian Siau Chen (seated) have found that sand can absorb more than 85 per cent of the energy exerted against it.

"These unique characteristics of sand may open up exciting new applications in areas that impact our daily lives, as well as in defence. For instance, steel, which is one of the key materials used in the construction of armour systems, can be partially replaced with sand as a cost-effective, environmentally friendly, and lightweight sacrificial layer, given its superior energy absorption performance. Given the possibility of hostile threats, sand could also be used as a complementary building material to steel to enhance protection of critical infrastructures and household shelters, given its projectile resisting function," added Asst Prof Chian.

The researchers will be conducting larger scale trials to further study the ability of sand to resist impact, as well as begin research into the energy absorption capabilities of similar materials, such as rock rubble.



ENERGY STORAGE INNOVATIONS RECEIVE EMA FUNDING

FOUR projects from NUS Engineering received a portion of the S$15 million in research grants given out by the Energy Market Authority (EMA) after a grant call was launched in May 2015. These four projects were among the six projects identified by EMA from over 30 proposals. The projects aimed to develop cost-effective energy storage innovations that could be deployed in Singapore. NUS Engineering's Centre for Energy Research and Technology (CERT) facilitated the grant applications by bringing in industry collaborators to the respective project teams.

The four projects funded by EMA are:

Condensed-phase Aqueous Redox-flow Battery (CARB) System: A Large-scale Stationary Energy Storage Technology for Near-term Deployment in Singapore

PRINCIPAL INVESTIGATOR: **Associate Professor Wang Qing, Department of Materials Science & Engineering**

Development of Sodium-ion Battery Pack for Stationary Storage Systems

PRINCIPAL INVESTIGATOR: **Associate Professor Palani Balaya, Department of Mechanical Engineering**

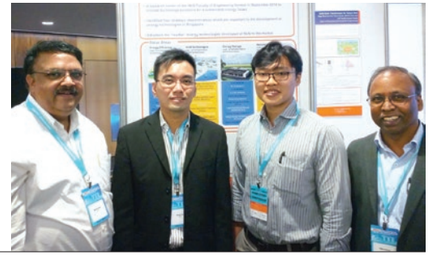
A Cost-effective Solidified Natural Gas (SNG) Technology for Energy Storage to Strengthen Energy Resilience in Singapore

PRINCIPAL INVESTIGATOR: **Associate Professor Praveen Linga, Department of Chemical & Biomolecular Engineering**

Development of High Performance and Energy Efficient Matrix Converter for Interfacing Battery Energy Storage with Utility Grid

PRINCIPAL INVESTIGATOR: **Associate Professor Panda Sanjib Kumar, Department of Electrical & Computer Engineering**

Assoc Prof Praveen Linga (right) with Prof Low Teck Seng, CEO of National Research Foundation [NRF] (middle), and Dr Yeoh Lean Weng, Director of NRF USS (left) at Energy Innovation 2016.



Assoc Profs Panda Sanjib Kumar (far left) and Palani Balaya (far right) with Dr Rendy Tan, NUS Enterprise, CERT (second left), and Marcus Chong, CERT (second right), at Energy Innovation 2016.

NURTURING HOLISTIC ENGINEERS
IMPACTING LIVES

OUR PEOPLE

> STAFF
> STUDENTS
> ALUMNI

RECOGNISED AT ASEAN OUTSTANDING ENGINEERING ACHIEVEMENT AWARDS 2016

PROFESSOR Lim Chwee Teck, Professor Hong Minghui, and Dr Luo Sha were recipients of the ASEAN Outstanding Engineering Achievement Awards 2016, in recognition of their significant contributions to the progress of engineering and quality of life in ASEAN countries. The awards were presented at the 34th Conference of ASEAN Federation of Engineering Organisations (CAFEO 34), held from 20 to 24 November in Manila, Philippines.

From left: Ajie Nayaka Nikicio, Harsh Kumar, Prof Lim Chwee Teck, Yeo Joo Chuan (Prof Lim's PhD student) and Prof Hong Minghui with the awards at the 34th Conference of ASEAN Federation of Engineering Organisations (CAFEO 34), held from 20 to 24 November in Manila, Philippines. Ajie and Harsh, research engineers from the Department of Electrical & Computer Engineering, received the award on behalf of Dr Luo Sha.

NUS Engineering researchers were conferred awards for their respective projects:

Prof Lim Chwee Teck
Department of Biomedical Engineering

PROJECT TITLE: ***Highly Flexible and Wearable Sensors for Real-time Healthcare Monitoring Applications***

The novel device, developed by Prof Lim and his PhD students, Yeo Joo Chuan and Kenry, is small, thin, highly flexible and durable, and is suitable for applications such as soft robotics, wearable consumer electronics, smart medical prosthetic devices, and real-time healthcare monitoring. It is a simple and cost-effective alternative to current conventional tactile devices that are rigid and bulky, restricting natural body movements, and which may also be subject to plastic deformation and failure when pressure is exerted.

Prof Hong Minghui
Department of Electrical & Computer Engineering

PROJECT TITLE: ***Seeing is Believing: from Microscope to Nanoscope***

To improve the resolution of a conventional light microscope, Prof Hong and his research team developed a super-resolution microsphere optical nanoscope, which breaks the conventional resolution limit with image object size as small as 23 nm. Their innovation generates great value for fields such as bio-chemistry, IC failure analysis and materials science. Besides scientific research, this new microsphere optical nanoscope can serve at schools as an educational tool; at hospitals for early detection of disease; and at homes for bacterial detection and ensuring food hygiene.

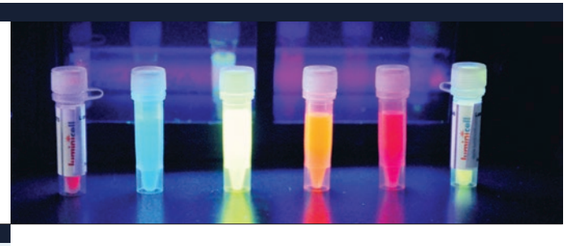
Dr Luo Sha
Department of Electrical & Computer Engineering

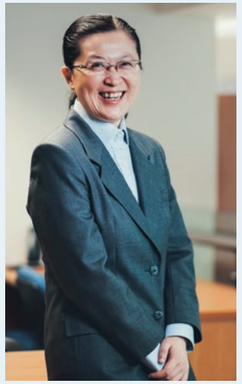
PROJECT TITLE: ***Galassia – NUS' First Nanosatellite***

Galassia is one of two satellites designed and built over four years by students from both the Aerospace Systems Initiative (ASI) programme under NUS Engineering's Innovation & Design-Centric Programme (iDCP) and the Department of Electrical and Computer Engineering (ECE). Led by Dr Luo Sha, one of its missions is to carry a quantum science payload developed by the NUS Centre for Quantum Technologies to test out the quantum-based communication concept using Small Proton-entangling System. The other missions are a novel Total Electron Count (TEC) payload and an experimental active Attitude Determination and Control payload developed by iDCP and ECE.

Galassia and *Kent Ridge 1* were successfully launched from the Satish Dhawan Space Centre in Andhra Pradesh, India, on 16 December 2015. They are the University's first satellites in space, and were part of six Singapore satellites that were launched in the same operation. *Galassia* remains in orbit, celebrating its first year anniversary in December 2016.

RESEARCHERS CLINCH 2016 NATIONAL TECHNOLOGY AND SCIENTIFIC AWARDS FOR EXCEPTIONAL INNOVATIONS





Prof Liu Bin and Dr Benjamin C.K. Tee clinched the President's Technology Award (PTA) and the Young Scientist Award (YSA) in 2016.

PROFESSOR Liu Bin, Department of Chemical & Biomolecular Engineering, was conferred the President's Technology Award (PTA) 2016 in recognition of her innovative research on organic fluorescent materials, particularly fluorogens with aggregation induced emission (AIE). The fluorogens have a wide range of applications in the fields of biomedical research, environmental monitoring and electronic devices. The PTA honours research scientists and engineers in Singapore who have made outstanding contributions to research and development, resulting in the invention or discovery of significant technology with industrial applications.

Prof Liu's AIE probe technology is timely; it specially addresses one of the challenges faced by rapidly developing cancer research and cell-based therapies, which require real-time non-invasive cell imaging and tracing technology. She co-founded an NUS start-up company, "Luminicell", to commercialise the breakthrough technology. Luminicell is currently working with international and local bio-tech companies to further develop and advance its technology.

Prof Liu has been listed in the Highly Cited Researchers report published by Clarivate Analytics, formerly the Intellectual Property & Science business of Thomas Reuters, since 2014.

Dr Benjamin C.K. Tee, Adjunct Assistant Professor, Department of Materials Science & Engineering, and the Department of Electrical & Computer Engineering, received the Young Scientist Award (YSA) 2016. The YSA recognises young researchers, aged 35 years and below, who are actively engaged in R&D in Singapore, and who have shown great potential to be world-class researchers in their fields of expertise.

Dr Tee created novel sensitive, self-healing, flexible and stretchable materials for next-generation human-machine interfaces that are applicable in robotics, healthcare and prosthetic devices, as well as the world's first repeatable self-healing electronic sensor skin by developing a unique composite material with hydrogen bonds as the repeatable healing mechanism.

His innovative work has received international awards. He is also a recipient of the Agency for Science, Technology and Research (A*STAR) National Science Scholarship.

BIOMEDICAL ENGINEERING TEAM'S ROBOTIC GLOVE BAGS GOLD

PHD student Yap Hong Kai (NUS Graduate School for Integrative Sciences and Engineering), together with his teammate Wu Po Cheng (undergraduate student) and team advisor Assistant Professor Raye Yeow, Department of Biomedical Engineering, clinched the top prize at the BES-SEC Design Award Competition, held at the 16th International Conference on Biomedical Engineering 2016 from 7 to 10 December.

Jointly organised by the Biomedical Engineering Society (Singapore) (BES) and the Society of Engineers for the Community (SEC), the competition challenges twelve international finalist teams to develop a low-cost medical device for resource-scarce communities.

The NUS Engineering team received the Gold Award for their project titled "EsoGloveX: An Economical Soft Robotic Glove for Hand Rehabilitation of Stroke Patients".

The innovative glove can assist stroke survivors with safe at-home robot-assisted hand rehabilitation, to prevent or treat post-stroke hand contractures and improve hand mobility. Compared with current conventional hand rehabilitation devices, which are costly, rigid and bulky, and restrict natural movements, the EsoGloveX is simple and cost-effective as it is made entirely of readily available fabric-based components, and does not require complicated mechanical setups.

The team has already filed a patent for their invention and an NUS spinoff company, Roceso Technologies Pte Ltd, has been incorporated to commercialise the EsoGlove series of soft robotic gloves.

From left: Asst Prof Raye Yeow and Yap Hong Kai with their award-winning EsoGloveX, a simple and cost-effective soft robotic glove to help stroke patients regain hand mobility.

FACULTY STAFF AND STUDENTS RECEIVE NATIONAL HONOURS

Assoc Prof Chua Kian Jon, Ernest (extreme right) and team members – Kwek Wen Lin (extreme left), Dr Md Raisul Islam (second left) and Balamuniappan Pranesh (second right) – received their IES Prestigious Engineering Achievement Awards 2016 on National Engineers Day (NED).

From left: Prof Lim Chwee Teck and his PhD students, Yeo Joo Chuan and Kenry, received their IES Prestigious Engineering Achievement Awards 2016 on NED.

AT this year's National Engineers Day, the following professors and their students were among the recipients of the IES Prestigious Engineering Achievement Awards, which recognise the achievements of engineers in Singapore through their outstanding engineering projects:

Professor Lim Chwee Teck, Department of Biomedical Engineering, and his PhD students, Yeo Joo Chuan and Kenry.

PROJECT: ***"Highly Flexible and Wearable Sensors for Real-time Healthcare Monitoring Applications"***

Engineering Science Programme students Au Khai Xiang, Balamuniappan Pranesh and Kwek Wen Lin, under the supervision of Associate Professor Anjam Khursheed, Associate Professor Chua Kian Jon, Ernest, Dr Md Raisul Islam and Mr Nelliyan Karuppiah.

PROJECT: ***"Smart White Cane", which caters to the needs of the visually handicapped***

Professor Hong Minghui, Department of Electrical & Computer Engineering, and his PhD student, Wu Mengxue.

PROJECT: ***"Seeing is Believing: From Microscope to Nanoscope"***

Liang Wenyu and Qin Geng, under the supervision of Associate Professor Tan Kok Kiong, Department of Electrical & Computer.

PROJECT: ***"Design & Development of Digital In-vitro Fertilisation (IVF) Device for Oocyte Retrieval"***

Dr Luo Sha, Department of Electrical & Computer Engineering, Dr Liaw Hwee Choo, Engineering Design & Innovation Centre, and their team.

PROJECT: ***"Galassia – NUS' First Nanosatellite"***

NUS ENGINEERING SCORES THREE AWARDS AT ICHEME SINGAPORE AWARDS 2016

ASSOCIATE Professor Rajasekhar Balasubramanian, Department of Civil & Environmental Engineering (CEE), topped a shortlist of eight to win the Energy Award (Singapore) at IChemE Singapore Awards 2016. The award is for his project titled *'Resource recovery from wastes'*, a novel waste treatment technology that converts urban waste streams into biofuels and other useful products. The project was pursued in collaboration with the Iowa State University (USA).

Assoc Prof Chua Kian Jon, Ernest (second right), Department of Mechanical Engineering, and Ms Betty Tsai (second left), an alumna from the Department of Chemical & Biomolecular Engineering, with other award recipients at the IChemE Singapore Awards 2016 held on 21 October.

Associate Professor Chua Kian Jon, Ernest, Department of Mechanical Engineering, picked up the Research Project of the Year Award (Singapore) for his project *'Membrane dehumidifiers to reduce energy consumption'*, in which he developed foil-like membranes to sieve out water molecules in air conditioning systems, reducing energy consumption by 35%.

The best Young Chemical Engineer in Research award went to Jinsong He, a PhD student from CEE. Her research focused on the development and applications of adsorption and membrane technologies for water treatment. She successfully developed a full-scale production system for metallic oxide nano-particles and two types of highly cost-effective membranes, for decontamination of toxic heavy metals from aqueous solutions.

Associate Professor Praveen Linga and Dr Hari Prakash Veluswamy, from the Department of Chemical & Biomolecular Engineering, received 'Highly Commendable Awards' in the following categories:

> Assoc Prof Linga and Lloyd's Register Global Technology Centre Singapore: Research Project of the Year Award (Singapore) for *"SNG – next generation natural gas storage technology"*,

> Dr Hari Prakash Veluswamy: Young Chemical Engineer in Research Award (Singapore).

Assoc Prof Praveen Linga and Dr Hari Prakash Veluswamy, both from the Department of Chemical & Biomolecular Engineering, with their 'Highly Commendable Awards' at the IChemE Singapore Awards 2016 held on 21 October.

INSPIRING MORE WOMEN ENGINEERS WITH THEIR WINS

ASSOCIATE Professor Ho Ghim Wei, Department of Electrical & Computer Engineering, and Engineering Science Programme, and Assistant Professor Shao Huilin, Department of Biomedical Engineering, are among the distinguished list of women who are changing the engineering industry in Singapore, and are inspiring – with their courage, determination and passion – more women to join the sector.

Assoc Prof Ho is the 2016 *Singapore Women's Weekly* Great Women of Our Time Award recipient in the Science and Technology category. The awards honour and highlight the talents and achievements of outstanding and high-achieving Singaporean women, who are inspiring pioneers and game changers that have made significant contributions in the different sectors in Singapore.

Believing that women can excel equally in the science, technology, engineering and mathematics (STEM) industry, Assoc Prof Ho strongly encourages women to "let your passion drive you, and do not be put down by failures or stereotyping." She currently leads the Ho Research Group at NUS Engineering, with the aim of creating novel nanostructured materials for energy and environmental sustainability.

Assoc Prof Ho Ghim Wei (centre) receiving this year's Great Women of Our Time Award in the Science and Technology category from Ms Indranee Rajah, Senior Minister of State, Ministry of Finance and Ministry of Law (left). Joining them is Ms Barbara Koh, *The Singapore Women's Weekly's* Editor-in-Chief (right).

Photo: *The Singapore Women's Weekly*

For her research in exosomes and their clinical potential, Asst Prof Shao Huilin was accorded the L'Oreal Singapore for Women in Science National Fellowship 2016. She received the 2016 physical and engineering science fellowship.

Exosomes are nanoscale vesicles that are actively secreted by cells and contain molecular information. In comparison to invasive tissue biopsies, exosomes can be repeatedly and conveniently obtained from biofluids, such as blood, hence offering a robust and non-invasive method for early disease detection and monitoring. Despite their clinical potential, the nanometer dimension of exosomes poses significant challenges for analysis, due to a lack of compatible technologies.

Asst Prof Shao's research focuses on integrating expertise in device engineering, materials science and molecular biology to overcome these technological challenges by developing new generations of nanotechnology-based biosensor platforms for sensitive, fast and cost-effective diagnostics.

"Emerging, unmet healthcare challenges will continue to drive my commitment in creating innovative technological solutions," said Asst Prof Shao. "I also hope that my work will encourage more young women to pursue STEM fields, and together, we can bring greater recognition to women who remain under-represented in the fields."

Asst Prof Shao Huilin receiving her award from Professor Leo Tan, Advisor to the Jury; Chairman, Science Sub-Commission Singapore National Commission for UNESCO, and Director (Special Projects), Faculty of Science, National University of Singapore.

Photo: L'Oréal Singapore

The L'Oréal Singapore for Women in Science National Fellowships programme is aimed at recognising ambitious and talented women in science, and encouraging young women to confidently pursue research. Organised annually, with support from Singapore National Commission for UNESCO and A*STAR (Agency for Science, Technology and Research), the fellowship awards two different grants of S$30,000 each, one in the field of Life Sciences and the other in the field of Physical and Engineering Sciences.

OTHER NOTABLE STAFF ACHIEVEMENTS

IN honour of their outstanding contributions to the field of biomedical engineering, **Prof James Goh** and **Prof Lim Chwee Teck** were inducted into the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE). They were formally inducted at AIMBE's 25th Annual Event held in Washington DC on 4 April.

Prof James Goh

Prof Lim Chwee Teck

Prof Lim Chwee Teck, a Provost's Chair Professor in the Department of Biomedical Engineering, and a Principal Investigator in the Mechanobiology Institute, was elected a Fellow of the International Academy of Medical and Biological Engineering (IAMBE) in honour of his distinguished contributions to and leadership in the field of medical and biological engineering on an international level.

Prof Philip Li-Fan Liu, Distinguished Professor in the Department of Civil & Environmental Engineering and Vice President (Research and Technology), was elected as an Academician of Academia Sinica by the 32nd Convocation of Academicians in Taipei, Taiwan. He is recognised for his expertise in the Engineering Sciences.

OTHER NOTABLE STAFF ACHIEVEMENTS (CONTINUED)

Assoc Prof Palani Balaya, Department of Mechanical Engineering, was recognised by the American Ceramic Society (ACerS) as an "ACerS Global Ambassador" for his outstanding efforts in developing global collaboration and outreach for the Society's initiatives, as well as for his leadership in the organisation of the Asia Pacific Ceramic Cooperation Summit held at the University in February 2016.

Asst Prof Yan Ning, Department of Chemical & Biomolecular Engineering, was presented with a Service Award in recognition of his outstanding contributions to the American Institute of Chemical Engineers (AIChE) Singapore Local Section.

Dr Thomas Teh, a research fellow with NUS Biomedical Engineering, received the prestigious Savio L-Y. Woo Young Researcher Award at the International Symposium on Ligaments & Tendons – XV (ISL&T-XV). The award is presented to young researchers who perform the best research studies in three major areas of the field – biomechanical, biological and clinical/translational. With Dr Teh's work on the augmentation of tendon graft anterior cruciate ligament reconstruction outcome using a silk-based osteoconductive sheath, he is the first to be recognised for the translational research category of this award.

Assoc Prof Chua Kian Jon, Ernest, Department of Mechanical Engineering, was conferred the WSSET (World Society for Sustainable Energy Technology) Innovation Award, under the theme of Energy Efficiency, at the 15th International Conference on Sustainable Energy Technologies in Singapore (19 to 22 July). He received the award for his research on the development of a hybrid membrane composite-desiccant air dehumidification system that has been successfully applied to the treatment of latent load due to humid air.

Asst Prof Duong Hai Minh won the 2016 TechConnect Innovation Award for the novel recyclable cellulose aerogels. He and his team from the Department of Mechanical Engineering created the world's first green cellulose aerogels made of paper waste. The non-toxic, ultralight, flexible, extremely strong and water repellent cellulose aerogels have a plethora of applications, including oil spill cleaning, heat insulation and packaging. They can also be potentially used as coating materials for drug delivery, as well as smart materials for biomedical applications.

The contributions of **Prof Ong Say Leong**, Department of Civil & Environmental Engineering, and **Assoc Prof Karl Erik Birgersson**, Department of Chemical & Biomolecular Engineering, were listed in Top 50 Engineering Feats @ IES-SG50 for their work on NEWater and the development of AIR+ Smart Mask respectively. Prof Ong was also among the National Day Awards recipients for 2016, receiving the Public Service Star Award for his contributions towards Singapore's water treatment and reclamation.

Prof Yong Kwet Yew, NUS Vice President (Campus Infrastructure) and a faculty member of the Department of Civil & Environmental Engineering, was awarded the MND Medallion for his distinguished service as Chairman of the Accreditation Selection Panel.

At SPRING Singapore's 50th Quality & Standards Anniversary Gala Dinner, Deputy Prime Minister & Coordinating Minister for Economic and Social Policies Mr Tharman Shanmugaratnam's speech showcased **Adj Assoc Prof Tam Chat Tim**'s contributions as one of SAC/SPRING's valued partners. Adj Assoc Prof Tam, Department of Civil & Environmental Engineering, was also presented with a plaque. His expertise in concrete materials and construction for tropical environments was instrumental in the revision of concrete standards in the 1980s. He was also involved in the adoption of Euro Codes Standards for concrete that are used in Singapore today.

Prof Ong Say Leong

Adj Assoc Prof Tam Chat Tim

Prof Neal Chung

Prof Neal Chung, Department of Chemical & Biomolecular Engineering, was conferred the inaugural Award of Distinction in the category for "Outstanding Professional in Water Reuse and Conservation" by the International Desalination Association in Nice, France on 5 October. He is recognised for his exceptional contributions to the development and implementation of landmark water reuse projects, and advancement of technology and applied science in the field of water reuse and conservation.

Asst Prof John Ho, Department of Electrical & Computer Engineering, was one of the ten honourees of the regional MIT Technology Review Innovators Under 35 competition for Southeast Asia, Australia, New Zealand and Taiwan, recognised for his research on "Wireless Technologies for Bioelectronics Therapies". As an honouree, Asst Prof Ho qualifies for consideration for the 2017 Global MIT Technology Review Innovators Under 35 List, which recognises the achievements of the world's top young innovators. The event will take place at the MIT Media Lab, US, in the fall of 2017.

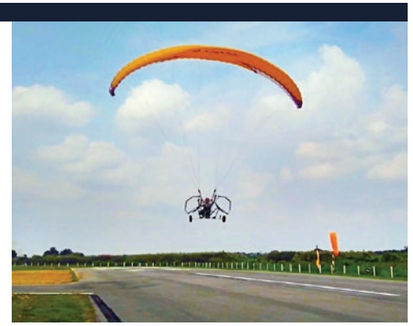
LEVERAGING DESIGN TO ENGINEER THE WORLD'S LIGHTEST AIRCRAFT

UNDAUNTED by the National Geographic Channel's challenge to create a 'fun' flying vehicle for its new series "Machine Impossible", eight students in NUS Engineering's Innovation & Design-Centric Programme (iDCP) designed and built the world's lightest electric paraglider trike over three months from January to March 2016.

"Designing and building *The Delta* was a learning experience like no other, as we went about tackling various aspects of the project, from constructing the physical frame to designing and implementing the aircraft's electric energy system and pilot safety system. It was an engineering challenge we greatly relished," said Chan Wai Yang, a Year 3 student at NUS Engineering.

The students faced several challenges. They had to identify the lightest airfoil possible, a wing, blade or sail crucial for flight, which was found in a conventional cloth paraglider. They had to seek out the lightest motors to provide sufficient thrust for *The Delta* to be airborne. And they had to build it light enough to fly, yet sturdy enough to be safe.

The aircraft's form is simple, minimalistic, yet sturdy. Powered by lithium polymer batteries, *The Delta* has a custom-built aluminium chassis with carbon fibre connections; two back wheels supported by a fiberglass rod suspension, and a front wheel connected to the steering, inspired by a child's tricycle; a seat for the pilot, an off-the-shelf paraglider, and two rear-mounted, horizontally arranged propellers, each driven by a motor. Pilot safety features include a protective roll cage, fibreglass rods to cushion the landing, barrier nets between the pilot and propellers, and emergency engine kill-switches.



***The Delta* weighs just 49 kg, and can fly up to a speed of 36 km per hour under normal wind conditions, for a typical flight time of 10 minutes on fully charged batteries.**

Weighing just 49 kg, it is the lightest aircraft in the world that can take off and land with wheels while carrying an adult pilot. It can carry one person of up to 75 kg, and fly up to a speed of 36 km per hour under normal wind conditions, for a typical flight time of 10 minutes on fully charged batteries. This enables the aircraft to cover a distance of 6 km, equivalent to the distance from the Central Library at the NUS Kent Ridge campus to the Singapore Botanic Gardens. *The Delta* takes off in a similar fashion to conventional aircraft – the motors power the propellers, which propel it forward. The propellers also generate sufficient draught to fully engage the paraglider's parachute at the back. Once *The Delta* gains a speed of around 30 km per hour, it takes off. *The Delta*'s maiden flight took place on 19 March at Sungai Rambai Aerodome in Malacca, and was successful at the first attempt.

Students and staff from the Innovation & Design-Centric Programme (iDCP) at NUS Engineering, together with the hosts of National Geographic Channel's *Machine Impossible* programme, Mr Mischa Pollack (front, left) and Mr Max McMurdo (front, right). Mr Brian Teo from the NUS Engineering team (front, centre) flew *The Delta* for its second flight.

CEE TEAMS EMERGE CHAMPS AT PRODUCTIVITY CHALLENGE 2016

FIVE undergraduate teams from the Department of Civil & Environmental Engineering (CEE) won four of the top five prizes at the third run of the Productivity Challenge 2016, including Champion and second runner-up.

Organised by the Building & Construction Authority (BCA) and held in conjunction with Singapore Construction Productivity Week 2016, the project-based competition for tertiary students, participating in teams of five, was held over a six-week period. Hands-on learning was encouraged to promote better understanding of the Buildability Legislation, and how it can impact design and construction practices in the industry.

Led by Prof David Chua and Prof Tan Kiang Hwee, the CEE undergraduate teams won four of the top five prizes, including the Champion and second runner-up, at the prize presentation on 20 October. The students were also guided by Mr Venkatesan Karthik during the modelling phase.

This year's challenge was based on 'Signature at Yishun' Executive Condominium, comprising three blocks of twelve-storey residential buildings with a Gross Floor Area of 15,858 square metres. Led by Professor David Chua and Professor Tan Kiang Hwee, and guided by Mr Venkatesan Karthik during the modelling phase, the CEE teams had to demonstrate their planning, as well as choice of buildable systems and labour efficient construction methods within a given set of parameters and constraints.

APPLAUDED FOR WORK ON INTERACTION OF NANOMATERIALS WITH BLOOD PLASMA PROTEINS

PhD student Kenry, NUS Graduate School for Integrative Sciences and Engineering, received the European Materials Research Society (E-MRS) Young Scientist Award for his research and technological development in functional materials at the E-MRS 2016 Spring Meeting and Exhibit held in Lille, France from 2 to 6 May.

Kenry's research, conducted under the direction of Professor Lim Chwee Teck, Department of Biomedical Engineering, is focused on the interaction of nanomaterials with blood plasma protein, in particular graphene oxide (GO), and if GO-based approaches could be effectively used to combat haematology-related disorders such as surface-activated thrombosis.

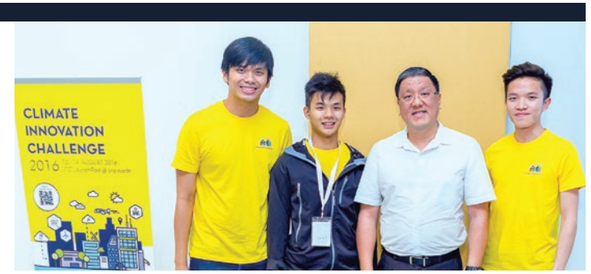
Kenry, a winner of the E-MRS 2016 Young Scientist Award, which was presented at the E-MRS 2016 Spring Meeting and Exhibit held in Lille, France.

The research also delves deeper into the absorption, binding kinetics and equilibrium, and conformational stability of plasma proteins with GO. Through his research, Kenry has found that GO and blood plasma proteins bind strongly, depending on the physical size of GO. Additional evaluation of the anti-thrombotic property of functionalised GO reveals its potential to mitigate haematological disorders. This facilitates further exploration into nanotechnology-based strategies for haematological and other biological applications.

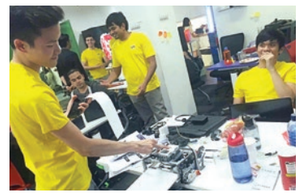
INNOVATIVE GREEN SOLUTION TO PAPER RECYCLING

LIM Zeming and Tan Yan Han, Year 4 Engineering Science Programme students, participated in the inaugural Climate Innovation Challenge from 12 to 14 August, a three-day hackathon organised by the Building and Construction Authority (BCA), Jurong Town Corporation (JTC) and National Climate Change Secretariat (NCCS), Strategy Group.

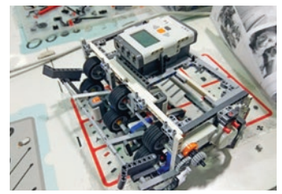
They built a fully functioning prototype using LEGO NXT in sixteen hours – a scanner-like machine that could take in a stack of used papers, and sort them into one-sided used paper (for reuse) and two-sided used paper. Zeming and Yan Han made it to the Final Judging, and were awarded a Special Mention prize of two thousand dollars in recognition of their ingenuity in addressing a problem in a simple and elegant manner. Their prototype was selected to be displayed at two exhibitions organised by BCA.



NUS Engineering students Lim Zeming (first left) and Tan Yan Han (first right) received a Special Mention prize in recognition of their ingenuity at the Climate Innovation Challenge. With them are Mr David Tan, Assistant CEO of JTC (second right) and Tan Wan Chi from NTU Aerospace Engineering (second left).



Tan Yan Han demonstrating how the scanner-like machine works.



A close-up of the fully functioning prototype built with LEGO NXT. The prototype was built within sixteen hours.

AWARDED S$75,000 SEED FUNDING AT MODERN AGING SINGAPORE

TWO Biomedical Engineering teams received seed funding amounting to S$75,000 at Modern Aging Singapore, a business accelerator initiative for silver sector-orientated innovations.

The top award of S$50,000 went to Team FlexoSense. Co-founded by Professor Lim Chwee Teck, the team is transforming pressure sensor technology into a smart insole to prevent diabetic foot ulcers. Diabetic foot ulcers affect one in six diabetic patients and, if left unchecked, can lead to lower limb amputation. FlexoSense's insole has a liquid-sensing element in microchannels in a flexible substrate that is able to detect applied pressure with pinpoint accuracy, thus allowing podiatrists to immediately determine whether an insole optimally fits the patient.

FlexoSense, which began in August, is already starting trials with several clinicians at Khoo Teck Puat Hospital. Collaborations with National University Hospital are ongoing.

From left: FlexoSense co-founder Yeo Joo Chuan, graduate student from NUS Graduate School for Integrative Sciences and Engineering; FlexoSense co-founder Mark Francis De Leon, Master's student in Management of Technology at NUS; Ms Chia Lye Peng, FlexoSense co-founder and NUS alumna; Benjamin Lee, Master's student in Management of Technology at NUS; and Prof Lim Chwee Teck.

Working together with Assistant Professor Raye Yeow, Team Oxyvel garnered S$25,000 for their silicone gel sheath. The invention hopes to reduce the possibility of pressure ulcers around the ears of patients requiring long-term oxygen therapy delivered through nasal prongs or a face mask. The current practice of using gauze overlay may lead to the development of a pressure sore and patients may then refuse therapy due to the pain and discomfort.

NUS FSAE R16 TEAM RANKED 12TH WORLDWIDE OUT OF 120 TEAMS

CHRISTENED 'R16', the NUS FSAE 2016 race car represents a key blend of technology and features with the unique NUS FSAE's signature car design. Following its launch on 6 April, the car was disassembled and shipped to Michigan, USA for the annual Formula SAE International Challenge, held from 11 to 14 May, where it raced to an impressive 12th position worldwide out of 120 teams.

At the Challenge, the NUS FSAE team was also ranked no. 1 for Marketing Presentation, no. 8 for Engineering Design, and no. 9 for Engineering Design Drawing.

Professor Seah Kar Heng, NUS FSAE Advisor, said, "Many things went wrong unexpectedly during this FSAE competition. Our students were able to make correct engineering decisions and had the quick reflexes to set things right on the car. I'm no longer shy to guarantee that these guys will make excellent engineers on graduation. Even the judges in the US were thoroughly impressed with their performance."

The NUS FSAE race car project started in 2001, and is now part of the Innovation & Design-Centric Programme, a unique learning pathway offered by NUS Engineering, where students from different engineering disciplines work together on multi-year projects to develop innovative technologies and solve problems affecting the community.

The NUS FSAE R16 team was ranked 12th worldwide, and also took the World Champion Award for Marketing Presentation; 8th in the world for Engineering Design; and 9th in the world for Engineering Design Drawing.

BUMBLEBEE SWIMS AND SAILS TO 4TH PLACE IN HAWAII

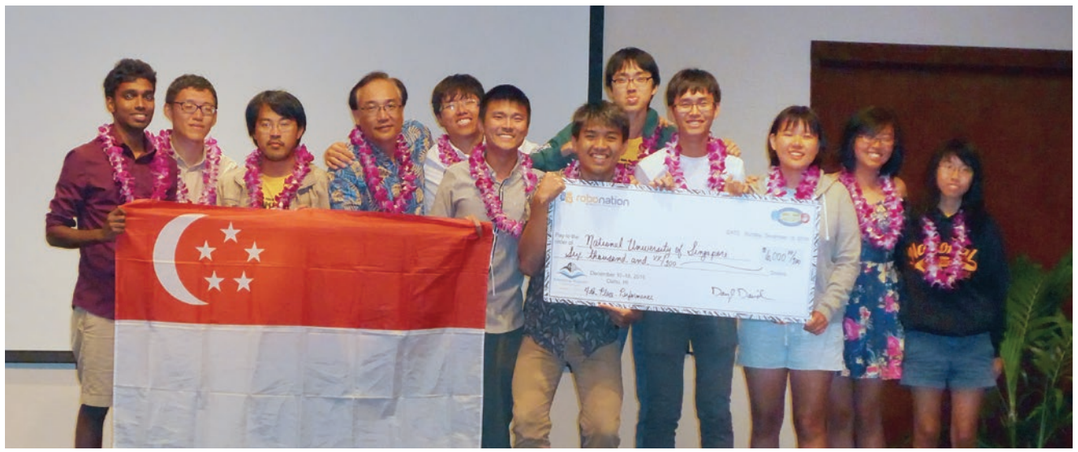
AT the 2016 Maritime RobotX Challenge held in Hawaii, the Bumblebee team was ranked 4th worldwide. It was the only finalist that had less than four months to work on its Autonomous Surface Vessel (ASV), as well as the only one with a fully undergraduate team.

From day one, the team faced various challenges, ranging from strong winds and currents, to ensuring sensors (such as LIDAR and GPS) worked accurately, and dealing with hardware damaged by the unfamiliar rocky sea conditions; four of the vehicle's thrusters and propellers were damaged. Despite the challenges and very little sleep, the team came together quickly to overcome the issues.

The Bumblebee Autonomous Surface Vessel (ASV) is the only finalist with a full undergraduate team.

Steven Harta Prawira, 2016 RobotX Team Captain, shared: "The result makes it easy to forget all the challenges that we had to overcome to get to where we are today. The team, as well as the supporting crew and organisations in Singapore, worked tirelessly to help us attain our goal. The team and I are humbled by the overwhelming support, and we will do better for the next competition."

Team Bumblebee has been flying the NUS flag at autonomous underwater vehicle (AUV) competitions since 2013, namely Robosub and Singapore AUV Challenge, and are seeking funding to continue engineering autonomous systems. They hope to complete an upgrade to the AUV, to undertake a redesign of the ASV based on the lessons learnt, and to deliver an integrated and fully automated Launch and Recovery system for the AUV by RobotX 2018.



Team Bumblebee at Maritime RobotX Challenge 2016, Hawaii. The team was ranked 4th worldwide at the challenge.

RECOGNISING THE ACHIEVEMENTS AND CONTRIBUTIONS OF NUS ENGINEERING ALUMNI

The DEAA 2016 winner Minister Masagos Zulkifli, (second left) and the EASH 2016 recipient Mr Leong Yue Wing (second right) with NUS President Prof Tan Chorh Chuan (centre), NUS Engineering Dean Prof Chua Kee Chaing (far left) and Vice Dean (External Relations & Outreach) Prof Victor Shim (far right).

The Distinguished Engineering Alumni Award (DEAA) 2016 was conferred on Mr Masagos Zulkifli, Minister for the Environment and Water Resources, who graduated from the National University of Singapore with First Class Honours in Electrical Engineering in 1988, and a Master of Science in Electrical Engineering in 1994. He began his career with Singapore Telecommunications Limited in 1988, and subsequently became the Chief Executive Officer of SingTel Global Offices. Minister Masagos believes in doing things with a heart, taking a keen interest in the welfare of Singaporeans. Joining the Public Service in 2006, Minister Masagos is actively involved in Muslim community affairs and grassroots activities, tirelessly engaging residents in Tampines as advisor to Tampines Grassroots Organisations. He also played a key role in the formation of Mercy Relief, which has evolved into one of the foremost disaster relief organisations in the region.

Mr Leong Yue Wing, who hails from the Mechanical Engineering Class of 1976, was the Engineering Alumni Service Honours (EASH) 2016 recipient. He has held top senior management positions in Philips Consumer Electronics and TCL Multimedia Technology Holdings Ltd, a company listed on the Hong Kong Stock Exchange, and was instrumental in their global business development and management. Today, Mr Leong is an independent company director in the TCL Group, and spends time mentoring young chief executives of mid-size enterprises and mid-career managers on how to globalise their businesses. He also serves and engages the NUS alumni community with untiring passion, and led a group of alumni, from the Engineering Class of 1976, to collectively establish a Faculty-level endowed bursary fund, known as the 'Engineering Class of 1976 Bursary Fund', to provide financial assistance to needy full-time undergraduates. The bursary fund stands at more than S$900,000, and has benefited 24 NUS Engineering students.

YOUNG INVENTORS' AWARD FOR YOUNG ENGINEERING RESEARCHERS

TAN Chuan Fu, a former student of the Engineering Science Programme, and Dr Zhu Liangliang from the Department of Electrical & Computer Engineering research team supervised by Associate Professor Ho Ghim Wei, clinched the Tan Kah Kee Young Inventors' Merit Award in the Open Category for their development of highly absorbent and solar-mediated carbon aerogel photocatalytic foam.

The utilisation of sustainable solar energy and material for environmental and energy remediation has always commanded great interest. Chuan Fu and Dr Zhu's invention encompasses intricate functional material design to achieve elevated absorbent and photocatalytic performances with unprecedented practicality in providing clean energy and air/water resources.

For air/water purification, the ultralight-weight and compressible properties of the foam allow easy and simple application. Its ability to readily absorb air/water pollutants also makes it adaptable for use in multiple scenarios, particularly useful in a water-scarce environment with limited stagnant water bodies. Moreover, its porous and compressible nature allows tailorable permeability levels to act as a versatile filtration system. With its photocatalytic capabilities, it offers much higher reusability compared to conventional filtration systems by degrading absorbed organic impurities.

The Tan Kah Kee Young Inventors' Award, which is given to outstanding inventors, seeks to inspire creativity among youths and promote an innovative and inventive culture. A prestigious and well-established invention award in Singapore, it attracted over 800 entries this year.

From left: The research team, comprising Tan Chuan Fu, Dr Zhu Liangliang and Assoc Prof Ho Ghim Wei from the Department of Electrical & Computer Engineering, at the awardee exhibition held in the Science Centre Singapore.

Right: Mr Ng Chee Meng, Minister for Education (Schools) & Second Minister for Transport (foreground), visiting the exhibition booth.

MAKING UNIQUE DINING CONNECTIONS ACROSS THE GLOBE

UNABLE to find a budget-friendly meal in Paris on Christmas Eve, two NUS Engineering alumnae, Rinita Vanjre Ravi and Inez Wihardjo, came up with BonAppetour (www.bonappetour), a highly successful web-based social marketplace that connects travellers with local chefs for unique and authentic global dining experiences beyond the typical tourist trail.

Rinita, a Chemical Engineering graduate, and Inez, who graduated from Electrical Engineering, launched the start-up while they were undergraduates. With support from NUS Enterprise, the pair – also alumnae of NUS Overseas College – received grants, mentorship, office space and networking opportunities. Since then, their business has flourished.

The venture's concept is simple. Interested cooks sign up with BonAppetour, providing details of their curated menus and prices.

Rinita (left) and Inez (right) with BonAppetour's Chief Technology Officer, Giovanni Casinelli.

Guests can browse the dining options available in the city they are visiting, ranging from brunches and barbecues to cooking classes and dinner parties, and make a booking through the integrated payment gateway. The local host is paid upon completion of the meal. A 15 per cent service fee, which goes to BonAppetour, is tacked onto the cost of the meal. This win-win collaboration allows hosts to earn income while showcasing and honing their culinary skills, and guests to enjoy delectable home-cooked meals and pleasant company in an immersive cultural setting,

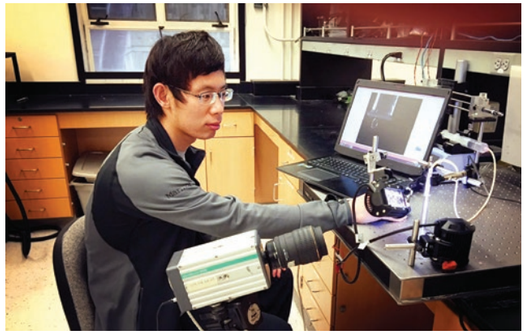
To ensure a safe experience for users of the service, BonAppetour performs background checks on the users, and offers a private messaging system for both parties to learn more about each other before agreeing to a transaction. Rinita and Inez also meet with hosts to ensure that hygiene, food preparation, ambience and hospitality criteria are met.

To date, more than 500 approved hosts have prepared meals for thousands of guests. BonAppetour now offers unique dining experiences in Italy, Africa, Asia, North America, Oceania and South America, and continues to seek out new exciting locations. Future plans include an app with an instant booking feature to match guests seeking home-cooked meals at short notice with willing hosts.

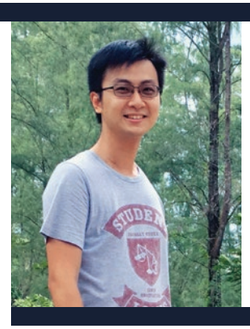
ACHIEVING HIS ASPIRATIONS IN ENGINEERING SCIENCE

PURSUING Engineering Science at the National University of Singapore has proven to be an invaluable decision for Wang Cong, a Class of 2013 alumnus, instilling in him a persistently inquiring mind that does not stop even when goals have been met. "The projects we had in Engineering Science involved the application of knowledge in multiple disciplines. This kind of training has enabled me to break barriers and to intuitively integrate knowledge and skills," said Wang Cong.

With such a positive mindset and strong foundation, Wang Cong went on to do his PhD at the California Institute of Technology (Caltech). While at Caltech, he developed technology that will pave the way for more efficient and smaller pressure valves suitable for applications in biomedicine as well as other fields. Using this technology, the valves can even be scaled down to nano size – small enough to be inserted into blood capillaries, for instance – without high cost, as they do not require a traditional mechanism that enables them to open and close. Experiment results demonstrate that the critical pressure that determines valve opening and closing can be tuned by adjusting surface hydrophobicity (water-repelling property) and opening size.



Drawing on his experience during his NUS undergraduate days, Wang Cong developed his groundbreaking valve design by venturing beyond what he was working on. "When I hit upon the idea of these valves, I was actually researching the effects of a super hydrophobic surface which could reduce drag and hence increase efficiency of liquid or gas transportation or container ship freight transport. Fundamental research can open doors that lead to vast potential applications."



OVERCOMING LIFE'S CHALLENGES IN PURSUIT OF EXCELLENCE

AT seven years old, Samuel Chong was diagnosed with bone cancer. He went through sessions of chemotherapy and had surgery. However, a relapse led to the loss of his left arm.

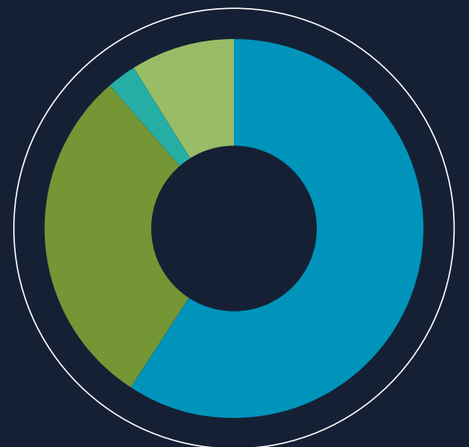
The experience did not rob Samuel of his enthusiasm and passion for life and learning; it only made him more resilient to life's challenges. A graduate of the National University of Singapore (NUS) Engineering Science Programme (Class of 2014), Samuel also received the CPG Book Prize, which was awarded to the top graduating student from his area of specialisation (Energy Systems). He went on to pursue his Masters in energy economics and engineering at Cornell University in the United States under a National Environment Agency (NEA) scholarship.

Today, Samuel is an Engineer at NEA, working in the Energy Efficiency and Conservation Department, where he oversees companies in the industrial sector to help them meet the mandatory energy management requirements and improve their energy efficiency. As part of NEA's efforts to help companies understand more about the energy efficiency landscape in Singapore, the Department conducts technical studies and Samuel manages some of these projects.

Samuel said, "I am also involved in roles that oversee policy and legislation. I am part of a team working on enhancing the Energy Conservation Act to improve energy management practices for industrial plants, amongst other initiatives. These will help Singapore reduce its carbon emissions and meet its carbon abatement obligations under the Paris Agreement."

Reflecting on his education, he said, "NUS Engineering has provided me with solid technical training. However, the non-engineering aspects of NUS are almost as important in my overall development. I am an alumnus of Tembusu College as well. The experience and modules taken there really broadened my horizons and I recommend all engineering students be exposed to non-engineering education."

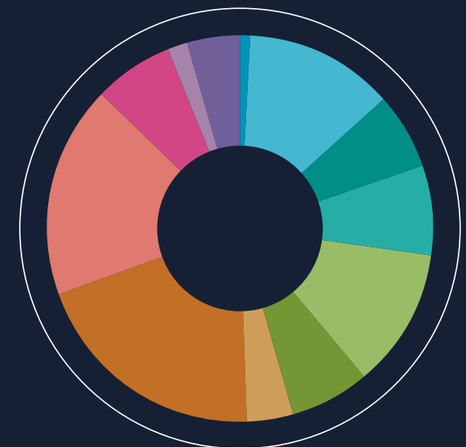
STUDENTS



CLASS OF 2016

BEng	1426
MSc	714
MEng	61
PhD	208
TOTAL	**2409**

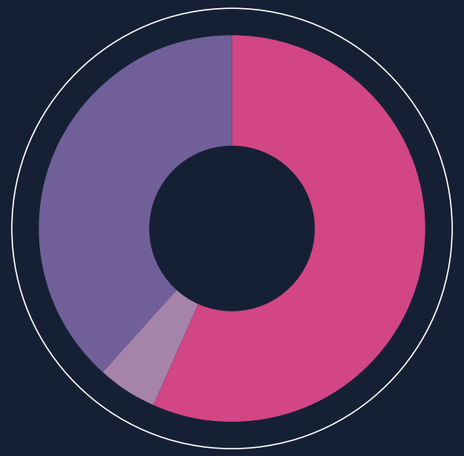
STUDENTS



UNDERGRADUATE STUDENT ENROLMENT

Engineering	62
B Tech	842
Biomedical Engineering	419
Civil Engineering	502
Electrical Engineering	778
Industrial & Systems Engineering	443
Materials Science & Engineering	261
Mechanical Engineering	1333
Chemical Engineering	1176
Computer Engineering	446
Engineering Science	117
Environmental Engineering	278
TOTAL	**6657**

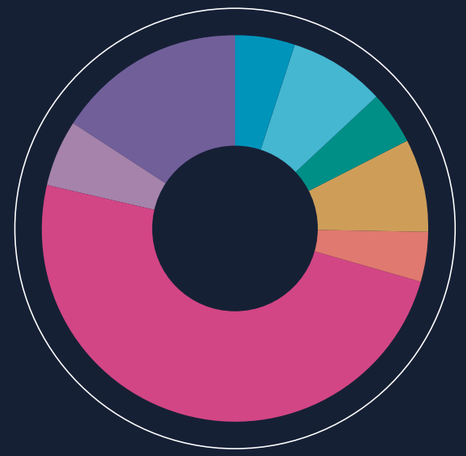
STUDENTS



GRADUATE STUDENT ENROLMENT

MSc	1422
MEng	129
PhD	958
TOTAL	**2509**

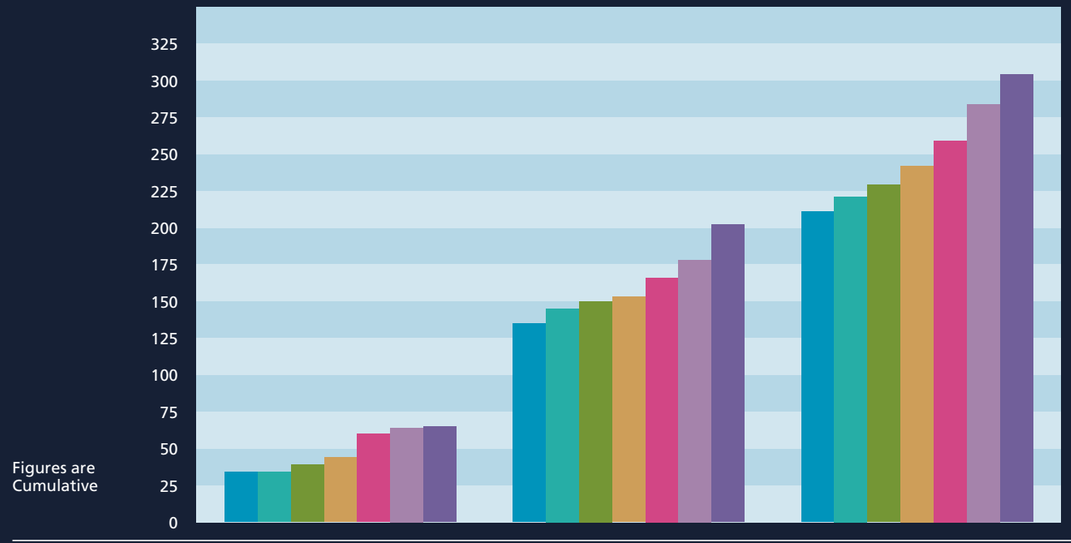
STAFF



STAFF PROFILE (AS AT 31 DECEMBER 2016)

Professors	85
Associate Professors	133
Assistant Professors	73
TOTAL NUMBER OF FULL-TIME FACULTY MEMBERS	**291**
Adjunct Staff	127
Other Teaching Staff	68
Research Staff	814
Executive & Professional Staff	89
Non-Academic Staff	261
TOTAL STAFF STRENGTH	**1650**

RESEARCH

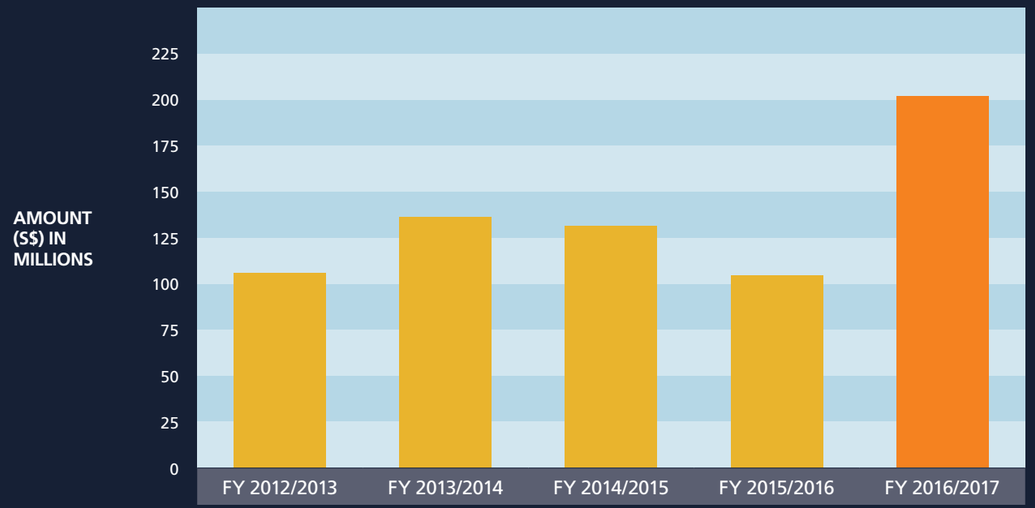


ENTREPRENEURIAL ACTIVITIES AT NUS ENGINEERING (AS AT 31 DECEMBER 2016)

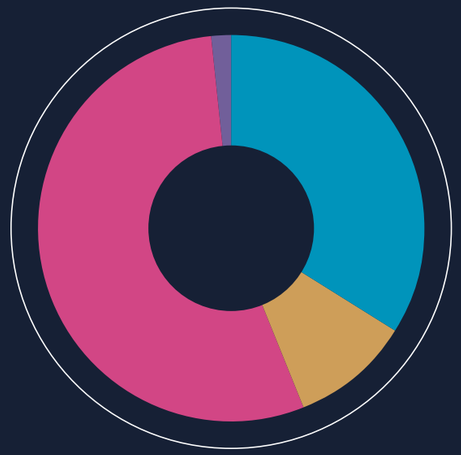
YEAR	SPIN-OFF / START-UP COMPANIES	LICENSED TECHNOLOGIES	INVENTIONS PATENTED
2010 and before	34	135	211
2011	34	145	221
2012	39	150	229
2013	44	153	242
2014	60	166	259
2015	64	178	284
2016	65	202	304

RESEARCH

RESEARCH GRANTS AWARDED TO NUS ENGINEERING
EXCLUDING RESEARCH SCHOLARSHIPS (AS AT 31 DECEMBER 2016)



GRAND TOTAL	**105,949,190**	**136,385,828**	**131,318,329**	**104,685,169**	**201,717,401**

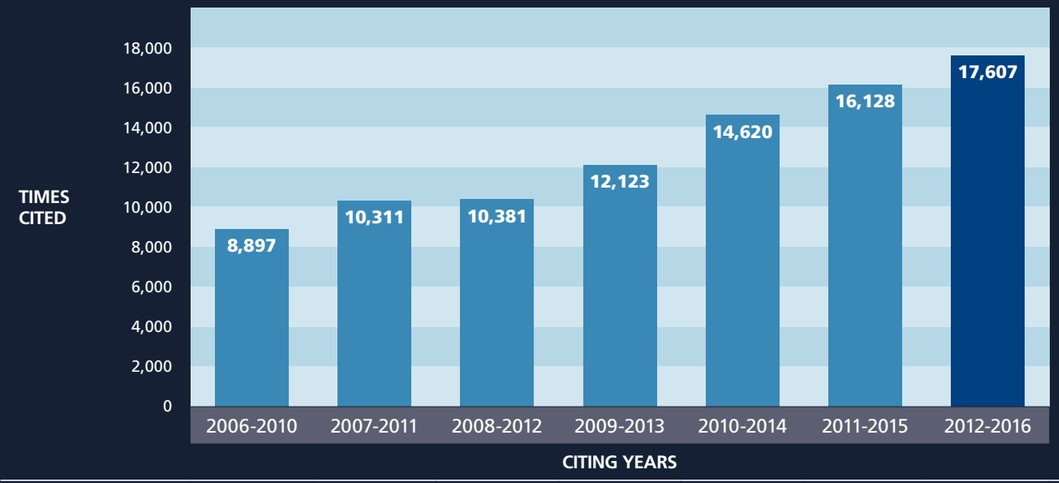


RESEARCH GRANTS AND SCHOLARSHIPS AWARDED IN FY 2016/2017 (AS AT 31 DECEMBER 2016)

MOE Research Grants	34.0%	**S$77,345,585**
MOE Research Scholarships	10.1%	**S$22,921,132**
External Research Grants	54.6%	**S$124,371,816**
External Research Scholarships	1.3%	**S$3,064,739**
GRAND TOTAL		**S$227,703,272**

RESEARCH

NUMBER OF CITATIONS (IN 5-YEAR INTERVALS)
Source: InCites Essential Science Indicators dataset updated 14 December 2016.

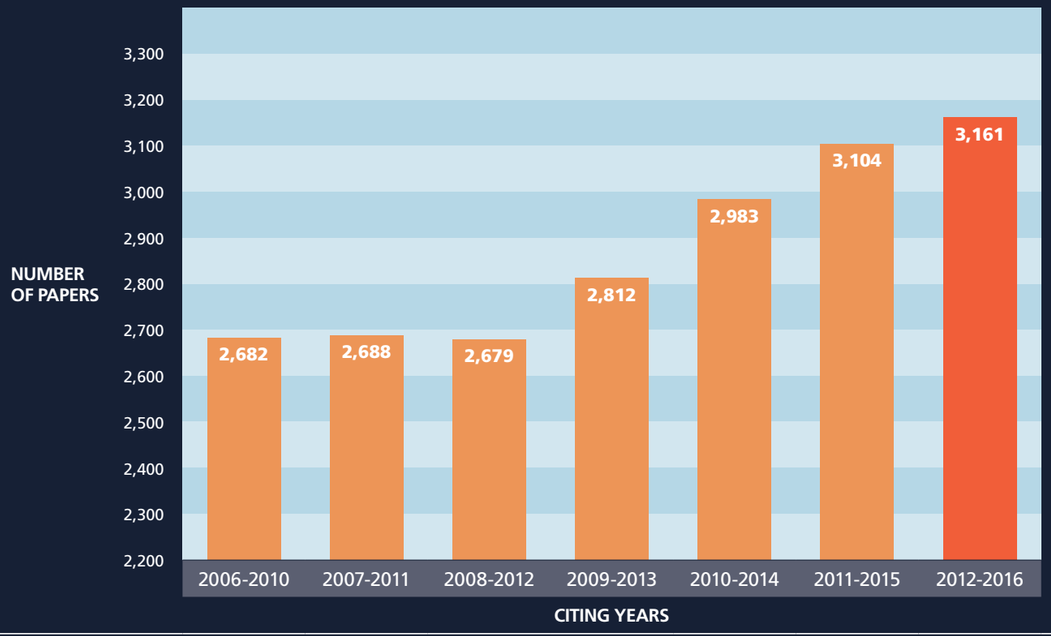


AVERAGE CITATIONS PER PAPER (IN 5-YEAR INTERVALS)
Source: InCites Essential Science Indicators dataset updated 14 December 2016.

RESEARCH

NUMBER OF PAPERS (IN 5-YEAR INTERVALS)

Source: InCites Essential Science Indicators dataset updated 14 December 2016.



NUS ENGINEERING

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