At NTU College of Engineering (CoE), we take a disciplined and distinctive approach to expanding the capabilities of our students, faculty members and researchers. As stewards of scholarly collaborations, innovation and entrepreneurship, we inspire individuals to seek new ways to turn ideas into solutions across diverse fields, challenge conventions and drive intellectual excellence. Together, we are ENGINEERING THE DIFFERENCE at CoE. Our goal is centred on becoming a global engineering leader in education, research and innovation.

VISION
A great global engineering college for education, research and innovation

MISSION
To nurture creative and entrepreneurial leaders through broad-based, research-infused engineering education and to advance knowledge and create innovative and sustainable solutions for the benefit of industry and society
Dean’s Message

Today, things seem to be moving at a pace so dynamic that it has become increasingly difficult for us to predict the future. In this rapid evolution, the only anchor seems to be a deep level of commitment to innovation, backed by the growth of new knowledge by individuals who are passionate about addressing real world challenges.

Through our scholarly explorations at NTU College of Engineering (CoE), we constantly envision the possibilities, tackle challenges and refine ideas that not only translate into improving the lives of people throughout the world but also, drive entrepreneurial and commercial success.

In fact, the theme for this year’s annual report, “Engineering the Difference” demonstrates CoE’s extensive innovation ecosystem that brings together various researchers, scholars, government agencies and industry leaders to promote research and educational excellence in an effort to maximise the positive impact of our explorations on society.

As I see it, our success over the years has been defined by the knowledge and the powerful research experiences that have provoked novel approaches in engineering technology-driven innovations, thus cementing our position as a globally recognised thought-leader. Through these efforts, we have improved our standings on various international ranking tables.

In the recent Quacquarelli Symonds (QS) World University Rankings by Subject 2017, CoE was ranked fourth in the world and first in Asia for Engineering and Technology. This is a big jump, rising from 14th to fourth in the world in a matter of just three years. How did we do it?
Exploring new fields, transcending boundaries

Bolstered by our success, we continued to break new ground in the area of research throughout 2016. Our faculty members have come through with cutting-edge research and ground-breaking innovations that transform lives, improve communities and enhance the way society lives.

Our highly collaborative, learning-infused community has also inspired many game-changing perspectives and multidisciplinary research approaches that have led to numerous new partnerships and collaborations with key industry players, locally and abroad such as Taiwan’s Delta Electronics, Sembcorp Marine, Singapore Mass Rapid Transit (SMRT), to name a few. The establishment of laboratories and centres of excellence at CoE throughout 2016 is a testament of the good work done by our researchers, backed by our strong commitment to reshaping the future and pioneering discoveries that will improve the quality of life for people around the world. These individuals have ventured into uncharted territories, taking intellectual risks to add value and make a difference in the way we live.

Fostering student excellence

We craft programmes that are not only relevant, but will positively impact the knowledge and learning process of our students.

For instance, our new Second Majors in Medical Biology and Pharmaceutical Engineering allow students to address the rising importance of materials designed for use with biological systems and acquire specialised knowledge on drug design and development specifically. In essence, our holistic and inclusive programmes allow students to explore different fields, acquire interdisciplinary perspectives, build entrepreneurship skills and gain incredibly powerful experiences, both in and out of their classrooms.

Creating the right mix of quality resources

The success achieved through our academic explorations and partnerships would not have been possible without the talent, drive and collaborative spirit of our faculty and staff who are the backbone of CoE. Comprising a community of intellectuals, they push the boundaries of science, provoke the development of knowledge and demonstrate their uncompromising standards of excellence.

We were also successful in proactively recruiting faculty members from leading institutions who are recognised leaders in their respective fields. The College recruited 35 full-time faculty members in 2016.

We also appointed 25 new Visiting Professors from various overseas tertiary institutions and 10 new adjunct faculty members from research institutions and private companies.

These additions are vital in terms of improving the quality and vibrancy of the faculty population. With our strong pool of faculty members, we are now in a strong position to compete with top universities around the world in attracting quality talent. It also further enhances and strengthens our ability to gain diverse perspectives, incubate ideas and drive new research that will shape a better future.

Designing the future of engineering

Together with our team of extraordinary individuals at CoE, we continue to contribute to the growth of research and education that will have a meaningful impact on all of those that have walked through our halls and those around the world.

To our Schools and colleagues, we would like to thank you for your dedication, tenacity and hard work because without you, our achievements would not have been possible.

It has been truly rewarding to see CoE advance to the next level in 2016. I believe that 2017 will be an even better year as we continue to deliver powerful solutions in the field of engineering research and education.

At CoE, we are truly Engineering the Difference.

Professor CHEN Tsuhan
Dean, College of Engineering
At the Dean’s Office

Professor CHEN Tsuhan
Dean

Professor WANG Xin
Associate Dean (Research)

Professor LEE Pooi See
Associate Dean (Faculty Recruitment and Development)

Associate Professor WONG Chee How
Associate Dean (Academic)
Global Standings

**NTU College of Engineering**

Our ongoing commitment in challenging the way we think, live and do things has clearly enriched the University and our position in academia and research, globally. A multidisciplinary and collaborative environment that encourages the generation of new knowledge, CoE continues to break new ground, delivering outstanding performance that has strengthened our position in the university rankings worldwide.

- **Quacquarelli Symonds (QS) World University Rankings for Engineering and Technology 2017**
  - **4th** in the world
  - **1st** in Asia

- **Essential Science Indicators 2017** by Clarivate Analytics
  - **5th** most cited university in the world

- **Times Higher Education (THE) World University Rankings in Engineering and Technology 2016-2017**
  - **18th** in the world

- **Academic Ranking of World Universities (ARWU) for the field of Engineering/Technology and Computer Sciences 2016** by ShanghaiRanking Consultancy
  - **2nd** in the world
  - **1st** in Asia

- **U.S. News and World Report’s Best Global Universities for Engineering 2017**
  - **6th** in the world
Delivering Impact
Made up of six engineering schools, CoE has engaged the best cadre of students and faculty to build an innovation ecosystem that best exemplifies excellence in engineering education and research.

Source: Quacquarelli Symonds (QS) World University Rankings by Subject 2017
FACTS AT A GLANCE

Driven to create new value and knowledge, we provide a nurturing ecosystem that supports the growth, creativity and success of our students, faculty members and researchers. Our unique combination of intellectual rigour, innovation and entrepreneurial success demonstrates the forward-thinking initiatives put in place to develop CoE as a leading institution in engineering education and research.
Faculty, Staff and Student Population

Undergraduate and Graduate Student Population

Breakdown of Graduate Student Population by Programme Type

Full time

Part-time

Total

13,637

Faculty and Staff Population

Breakdown of Undergraduate Student Population by Programme Type

Total

10,503

FACTS AT A GLANCE
Faculty Recruitment and Research

No. of Newly Hired Faculty

Research Funding FY2016
(April 2016 to March 2017)
As at 31 December 2016

Engineering Citations

Total Citations
(5-Year Intervals)

Average Citations Per Paper
(5-Year Intervals)
MAPPING NEW WAYS TO TEACH, LEARN AND SHARE

We walk alongside creative minds and future leaders, and nurture them on their journeys of learning, discovery and excellence. Our well-rounded curricula, holistic teaching pedagogy as well as diverse and enriching environment, all come together to mould a generation of dynamic young talents.
EDUCATION:
Intelligent Exchange, Experiential Learning and Entrepreneurial Success

The College of Engineering is focused on nurturing students who are prepared to make a difference in the world, through a unique combination of exciting student life and rigorous academic exploration. Our programmes are designed to offer students a complete education experience, and train future engineers and thought leaders to achieve their full potential and beyond.
Undergraduate Studies

With more than 10,000 undergraduates from diverse background across six schools, we have in place broad, innovative and industry-relevant programmes. These programmes allow students to pursue their ambitions and take charge of their own learning process, based on their strengths, abilities and interests.

In addition to the single degree programmes, students can also read a double degree, second major or take up a minor with choices from over 35 disciplines. There is also the Renaissance Engineering Programme (REP) which awards a Bachelor of Engineering Science and Master of Science in Technology Management at the end of four and a half years. These programmes are conducted in collaboration with leading-edge institutions such as London’s Imperial College, University of California, Berkeley and Canada’s University of British Columbia, as well as with public agencies and industry.

We offer 11* single-degree Bachelor of Engineering programmes and a Bachelor of Science in Maritime Studies.

* All Bachelor of Engineering programmes are accredited by The Institution of Engineers Singapore, the Singapore signatory of the Washington Accord, through its Engineering Accreditation Board. The Washington Accord is an international agreement for mutual recognition of the substantial equivalence of engineering academic programmes in satisfying the academic requirements for the practice of engineering at the professional level.
CoE’s strong relationships with industry partners have also enabled the College to offer robust professional internship programmes that provide students with industry exposure and prepare them for their careers. Global immersion programmes deliver a multi-faceted experience, broadening students’ horizons and helping them build networks that will enrich and enhance their educational experience.

With our holistic approach, students are well equipped with technical competencies as well as soft skills such as communication, analytical and entrepreneurial capabilities essential to take on challenges of the future.

Drifting Innovation and New Knowledge
Outstanding second and third year undergraduates are invited to participate in the University’s Undergraduate Research Experience on Campus (URECA) programme. Through URECA, these students are given the opportunity to pursue independent research under the supervision of a professor over a period of 11 months where they will experience a research environment that is second to none. They are also conferred NTU President Research Scholar (NTU PRS) status.
Our Academic Offerings

Below is a list of degree programmes offered in 2016:

**Bachelor of Engineering (B.Eng.) Programmes**
- Aerospace Engineering
- Bioengineering
- Chemical and Biomolecular Engineering
- Civil Engineering
- Computer Engineering
- Computer Science
- Electrical and Electronic Engineering
- Environmental Engineering
- Information Engineering and Media
- Materials Engineering
- Mechanical Engineering

**Bachelor of Science (B.Sc.) Programme**
- Maritime Studies

**Double Degree Programmes**
- Computer Engineering and Business (with specialisation in Business Analytics)
- Computer Science and Business (with specialisation in Business Analytics)
- Engineering* and Economics

**Second Majors**
- Bachelor of Engineering in your chosen major with a Second Major in Business
- Bachelor of Engineering in Bioengineering/Chemical and Biomolecular Engineering with a Second Major in Food Science and Technology*
- Bachelor of Engineering in Materials Engineering with a Second Major in Medical Biology*
- Bachelor of Engineering in Bioengineering/Materials Engineering with a Second Major in Pharmaceutical Engineering*
- Bachelor of Engineering in Civil Engineering/Electrical and Electronic Engineering/Environmental Engineering/Mechanical Engineering with a Second Major in Society and Urban Systems
- Bachelor of Science in Maritime Studies with a Second Major in Business

**Integrated Programme**
- Renaissance Engineering Programme (REP)

* In a chosen major
NTU College of Engineering has launched several new highly interdisciplinary engineering programmes with second majors in rapidly expanding fields to cater to the rising demand for engineers with qualifications and broad skills beyond their core disciplines.

New Programme Offerings

Bachelor of Engineering in Materials Engineering with a Second Major in Medical Biology

The advent of regenerative medicine has seen the development of a new and emerging field of materials science and biology. The Bachelor of Materials Engineering with a Second Major in Medical Biology programme was introduced to address the rising importance of materials designed for use with biological systems. Further to this, it will also look into materials derived from biological systems for medical and other applications. This programme is set to enhance students’ knowledge in medical biology, especially in the principles of biological science.

Graduates will enjoy the flexibility of choosing from a wide range of career options and roles across diverse industries, in addition to biomedical industries both locally and abroad.
Bachelor of Engineering in Bioengineering with a Second Major in Food Science and Technology

The Second Major in Food Science and Technology is a collaboration between NTU and the prestigious Wageningen University from the Netherlands, whose Food Technology programme is considered one of the best and most innovative in Europe. Previously available for students reading Chemical and Biomolecular Engineering, this second major was made available to students reading Bioengineering in 2016. Five core courses will be taught by the faculties from Wageningen University with coordinators at NTU.

Students will be at the forefront of resolving current and future challenges in food security for Singapore and beyond. These include system integration for enhanced food production, novel technologies for food waste reduction and conversion, food nutrition for an ageing population, as well as risk analysis and management in food safety.

The Second Major in Food Science and Technology will open up myriad career opportunities in food industries including multinational corporations, government regulatory agencies, research institutions and local organisations.

Bachelor of Engineering in Bioengineering/Materials Engineering with a Second Major in Pharmaceutical Engineering

Over the last decade, Singapore has positioned itself as a biopharmaceutical manufacturing hub and top manufacturing site for active pharmaceutical ingredients and solid dosage drugs globally. The Bachelor of Engineering in Bioengineering/Materials Engineering with a Second Major in Pharmaceutical Engineering programme was introduced to build a talent pool of biopharma engineers and encourage enriching research innovations. Students in these two programmes will gain specialised knowledge in drug design and development. They will also have opportunities to work with leading biopharmaceutical companies to gain first-hand experience in drug design and development.

This programme prepares students for exciting and meaningful careers in the pharmaceutical industries, spanning key sectors such as pharmacy and biotechnology, biomedical and clinical sciences, healthcare as well as research and development.
Programme Highlight

Renaissance Engineering Programme (REP)

A Premier Scholars Programme, the Renaissance Engineering Programme (REP) is today the top engineering programme in Singapore since it was launched five years ago.

The goal of this programme is to nurture top engineering leaders with strong entrepreneurial spirit and service excellence. It has in place a broad-based, inter-disciplinary education approach that integrates engineering, science, business, technology management and humanities.

Through our transformational and highly-interactive programmes, students will be exposed to learner-driven experiences, the art of negotiation and teamwork. In addition to new teaching pedagogy such as flipped classrooms and team-based learning by the university’s top faculty, they are also required to take up the Renaissance Engineers Advance in Leadership course. Here, they will be trained by experienced industry leaders and facilitators to be impactful, forward-thinking and problem-solving leaders of the future.

This fully residential programme will offer students a myriad of exposure that arm these future leaders with a broad and global mindset. To increase their competencies and exposure, they have the opportunity to go overseas for one year, gaining invaluable experiences at world-renowned universities such as University of California, Berkeley (USA), Imperial College London (UK) and Northwestern University (USA).

During their time abroad, they will also have access to internships with start-ups and multinational companies. This provides students with the opportunity to widen their perspective of the working world. It also enhances their employability and career mobility worldwide upon graduation and prepares them to compete locally and internationally.

Upon completion of this unique curriculum, students will be awarded a Bachelor of Engineering Science with a specialisation in a preferred engineering discipline by the College of Engineering and a Master of Science in Technology Management from the Nanyang Business School.
Graduate Studies

CoE is essentially a melting pot with over 3,000 graduate students from all over the world, gathering to deepen their knowledge and gain a richer education experience. Our learning-infused community consists of 60 percent research students while the remaining 40 percent are pursuing graduate degrees through coursework.

Fostering a Global Mindset
CoE collaborates with global partners to offer dual or joint degree programmes that offer students the ideal multidisciplinary and collaborative environment. The programmes are designed to enable them to have deeper interactions with world-renowned faculty and researchers.

Students reading dual or joint degree programmes are able to study under faculty members from both universities and also attend classes at both campuses.
Graduate Studies

The list of graduate programmes offered in 2016:

**Coursework Programmes**
Programmes by coursework lead to Master of Science (M.Sc.) degrees.

**School of Chemical and Biomedical Engineering**
- M.Sc. (Biomedical Engineering)

**School of Civil and Environmental Engineering**
- M.Sc. (Civil Engineering)
- M.Sc. (Environmental Engineering)
- M.Sc. (International Construction Management)
- M.Sc. (Maritime Studies)

**School of Computer Science and Engineering**
- M.Sc. (Embedded Systems)
- M.Sc. (Digital Media Technology)
- M.Sc. (Information Systems) in collaboration with Wee Kim Wee School of Communication and Information

**School of Electrical and Electronic Engineering**
- M.Sc. (Communications Engineering)
- M.Sc. (Computer Control and Automation)
- M.Sc. (Electronics)
- M.Sc. (Green Electronics) - Joint degree with Technical University of Munich, Germany
- M.Sc. (Integrated Circuit Design) - Joint degree with Technical University of Munich, Germany
- M.Sc. (Power Engineering)
- M.Sc. (Signal Processing)

**School of Mechanical and Aerospace Engineering**
- M.Sc. (Supply Chain and Logistics)
- M.Sc. (Manufacturing Systems and Engineering)*
- M.Sc. (Mechanical Engineering)*
- M.Sc. (Precision Engineering)*
- M.Sc. (Smart Product Design)*
- M.Sc. (Aerospace Engineering) - Joint degree with Technical University of Munich, Germany
- M.Sc. (Project Management) - Joint degree with The University of Manchester, UK
- M.Sc. (Systems and Project Management) and Dual Masters Programme – with Stevens Institute of Technology, USA

* Options for specialisations in Additive Manufacturing, Optical Engineering, Naval Architecture and Marine Engineering are available for selected M.Sc. programmes.

**Research Programmes**
All our engineering schools offer research degree programmes that lead to Master of Engineering (M.Eng.) or Doctor of Philosophy (Ph.D.) degrees.
The seminar culture programme will broaden the knowledge of graduate students and enhance their critical thinking in research.

Fostering a Collaborative Culture

Driving Academic Exploration through Seminar Culture Programmes

To create a culture where the meeting of minds will bring forth more intellectual discussions and collaborations, CoE has established a seminar culture programme for all graduate students. Under this mandatory programme, students have to undertake 10 seminars each academic year.

School of Computer Science and Engineering and PayPal Join Forces to Advance Research Training

The School of Computer Science and Engineering and PayPal signed a framework agreement for the training of Ph.D. students on 1 August 2016. Under this agreement, students will also work as PayPal employees. Research projects undertaken by the students will not only add value but also promote more avenues for collaborative research in the future.
WORKING TOGETHER FOR REAL RESULTS

Always on the forefront of innovation and technology, our faculty, students and researchers are constantly pursuing fresh discoveries and seizing new opportunities. Through partnerships with government agencies, distinguished corporations, peer universities and more, we engineer real-world innovations and future-ready solutions that make a difference.
RESEARCH:
Leading-edge Collaborations, Revolutionary Discoveries and Game-changing Innovations

Over the years, we have built a distinctive culture of research inquiry and development that allows our scholars and researchers to question things around them, openly exchanging a multitude of perspectives that has become a fundamental ingredient in the growth of the College. We believe that this constant flow of stimulating ideas contribute to the fabric of our learning-infused community, delivering ground-breaking innovations that have meaningful impact on human life.
Research Achievements

New opportunities for achievements abound in 2016. The College aligned our research effort with those of Singapore’s latest National Research, Innovation and Enterprise 2020 (RIE2020) plan. New programmes, initiatives and collaborations were introduced and fostered, to position us for competitive growth and performance.

Exciting research initiatives in 2016
In 2016, the Singapore Government unveiled the RIE2020 plan that charts the research and development directions for the nation over the next five years. Under RIE2020, four technology domains were identified, namely Advanced Manufacturing and Engineering; Health and Biomedical Sciences; Services and Digital Economy; and Urban Solutions and Sustainability. The roadmap introduced many exciting research possibilities and scholarly collaborations for the College of Engineering (CoE).

To seize opportunities, several support schemes were formulated at CoE to encourage inter-school multidisciplinary programmes that are aligned along the four domain areas covering Advanced Manufacturing and Engineering, Flexible Devices and Precision Biology.

Initiatives such as the Advanced Manufacturing and Engineering Centre, Innovative Centre for Flexible Devices, Centre for Precision Biology, and Data Science and Artificial Intelligence Research Centre were developed.

At the same time, earlier efforts to partner lead agencies and industry bore fruit. CoE finalised and launched the Corporate Laboratory with Singapore Mass Rapid Transit (SMRT); set up the Rehabilitation Research Institute of Singapore, a S$100 million joint-investment by NTU, the Agency for Science, Technology and Research (A*STAR) and the National Healthcare Group; as well as the Transport Research Centre (TRC@NTU) in collaboration with the Land Transport Authority of Singapore (LTA).

On the medical front, the School of Chemical and Biomedical Engineering partnered with the NTU Lee Kong Chian School of Medicine through a joint grant to unlock new possibilities in the biomedical arena.

At the School of Materials Science and Engineering (MSE), advanced materials characterisation capabilities received a boost with the installation of a state-of-the-art electron microscope facility. A staff and student exchange programme was also initiated between MSE and the Peter Grünberg Institute in Jülich, both leaders in the field of microscopy.
During the year, CoE also sealed partnerships with ST Engineering as well as Delta Electronics to set up joint laboratories focusing on advanced robotics, autonomous systems and cyber-physical systems research respectively. These partnerships attested to the industry-relevance of our research.

On the international collaboration front, we entered into the second phase of our partnership with Hebrew University of Jerusalem via the Campus for Research Excellence and Technological Enterprise (CREATE) programme to work on innovative manufacturing with advanced materials for Energy and Energy-Water Nexus. We also established alliances with the Russian Academy of Sciences and Moscow State University on energy storage and efficiency research.

Corroborating the societal impact of our research, CoE garnered close to S$30 million translational research monies for Smart Platform Infrastructure Research, Waste-to-Energy Research, Geodata Modelling and Management for underground space development, well-aligned to national initiatives like the Smart Nation programme and Sustainable Cities.

The vibrancy of research has been palpable in 2016, attributable to the extraordinary contributions of faculty and staff. This participative spirit and constant flow of ideas will continue to distinguish CoE from the rest, and this places us in a strong position for future achievements.

This participative spirit and constant flow of ideas will continue to distinguish CoE from the rest, and this places us in a strong position for future achievements.
Blazing New Trails

We are constantly pushing new frontiers of research in order to expand human knowledge, and find new ways to improve the quality of living. Through our collaborations and partnerships, we encourage multidisciplinary interactions that not only enrich our community but also allow us to design real-world solutions that deliver powerful experiences.

Pushing the Boundaries of Research

Aerogel thin foam keeps vehicles and buildings cooler and quieter

In an effort to address the real market need for high-performance heat insulation and better sound proofing, Associate Professor Sunil Chandrakant Joshi from the School of Mechanical and Aerospace Engineering and his former Ph.D. student, Dr. Mahesh Sachithanadam have developed Aerogel Composites, a new thin foam that insulates against heat 2.6 times better than conventional ones.

Developed over a period of four years, Aerogel Composites, which is made from silica aerogels with a few other additives, can block out 80 percent of outside noise. This is essentially 30 percent more than the current conventional materials available.

Given that more global industries are moving towards green manufacturing and a lower carbon footprint, this new foam is eco-friendly and less hazardous as high heat treatment and toxic materials are not required during production. It is also more resilient, better able to withstand high compression, boasts higher performance and is easy to install.

It is an extremely good thermal insulator, which is a crucial factor for materials used in high heat environments common in the oil and gas industries. The technology has also been published in peer-reviewed scientific journals and a monograph, while a patent has been filed by NTU’s innovation and enterprise arm, NTUitive.

A local company, Bronx Creative & Design Centre Pte Ltd (BDC), has licensed this Aerogel Composites technology with a joint venture of $7 million (US$5.2 million). A production plant that is being set up is expected to be operational by 2017. Branded by BDC as Bronx AeroSil, it has the potential to be used in a wide range of applications, including in-building and construction, electronics, oil and gas as well as automotive industries.

Moving forward, BDC is working towards producing Aerogel Composites in various forms such as sheets or panels, in line with current industry sizes. Further research and optimisation is still being conducted on this aerogel composite's performance to ensure it maintains its competitive edge against other technologies.
Blazing New Trails

Transforming Singapore’s underground construction industry with biogROUT

Recognising that the conventional biogROUT was not feasible to be used to seal all the cracks or joints in soil and rock, Professor Chu Jian from the School of Civil and Environmental Engineering (CEE) and his team of researchers made a breakthrough with the development of a new biogROUT.

Together with Associate Professor Tan Soon Keat and Associate Professor Zhao Zhiye, also from the School of CEE, the team’s newly developed biogROUT will ensure grouting for seepage control in underground construction more effective, efficient and feasible for urban applications.

In comparison to existing grouting materials, this new biogROUT is more cost effective as it consumes less energy during the production process; and can be produced using activated sludge, which in turn reduces the cost of biocement significantly and the amount of sludge disposed. In addition, no ammonia gas is produced during the biogrouting process, making it feasible for urban applications for the first time. This new biogROUT can also flow like water and permeate even the finest cracks.

Given this new biogROUT’s commercialisation potential, two disclosures and further patent applications are currently in progress.

Meanwhile, further research is ongoing to strengthen the capabilities of this product, with trials currently being conducted at a construction site.

The team’s newly developed biogROUT will ensure grouting for seepage control in underground construction more effective, efficient and feasible for urban applications.
Magnetic microbubble technology for cancer therapy

A multidisciplinary team of researchers from NTU have invented a first-of-its-kind non-invasive, patient-friendly and cost effective method to deliver cancer drugs deep into tumour cells.

Led by Assistant Professor Xu Chenjie from the School of Chemical and Biomedical Engineering and Associate Professor Claus-Dieter Ohl from the School of Physical and Mathematical Sciences, this new method may solve current challenges faced in chemotherapy treatment.

Traditionally, chemotherapy treatment is largely non-targeted and allows drug particles to flow into the bloodstream, causing damage to both healthy and cancerous cells. While these drugs are usually flushed away by organs, the remaining ones are not able to penetrate to the core of the tumour and this could lead to tumour regrowth.

The team created micro-sized gas bubbles coated with cancer drug particles and iron oxide nano-particles. Magnets are applied to direct these bubbles to gather around a specific tumour. An ultrasound is then used to vibrate the microbubbles, providing the energy to direct the drug particles to reach the cancer cells on the surface and also inside the core of the tumour.

The innovative technique allows the drugs to penetrate a depth of 50 cell layers or more – which is about 200 micrometres, twice the width of a human hair. A clear benefit is that healthy cells are not impacted by this treatment.

The microbubbles were successfully tested on mice and the study has been published by the Nature Publishing Group in Asia Materials, the top journal for materials sciences in the Asia-Pacific region.

This study, which took two and a half years, involved a 12-man international interdisciplinary team consisting of NTU scientists as well as scientists from City University of Hong Kong and Tel Aviv University, Israel. Two NTU undergraduates doing their Final Year Project and one student in Summer Research Internship Programme (NTU) were also part of the team.

Moving forward, the team will be adopting this new drug delivery system in studies on lung and liver cancer using animal models.
Let your hands do the talking...
Imagine using your hands to control your home appliances. Or even better, machines that can understand sign language!

These could soon become a reality with the latest work by Associate Professor Yuan Junsong’s research group from the School of Electrical and Electronic Engineering. The group has pioneered the use of robust hand gestures to understand and interact using depth cameras, such as Microsoft Kinect. Here, the team developed computer vision and pattern recognition methods to enable intelligent human-machine interaction via hand gestures.

“Although humans can perform naturally well, analysing and understanding human hand gestures are not easy for machines. Compared to whole-body gestures, hands are much smaller objects with more complicated articulations, which are easily subject to image sensing errors. Therefore, robust and efficient hand gesture recognition for real-life application is very challenging,” explained Associate Professor Yuan.

By accurately capturing the hand gestures, the team employed several prototypes for recognising hand sign languages. These include interacting with robots and virtual objects with hands as well as playing a virtual piano on a piece of white paper.

Sponsored by the Nanyang Assistant Professorship and Microsoft Company, this research received the best paper award of IEEE Transaction on Multimedia in 2016.

A “break” – through discovery
A team of researchers from the School of Electrical and Electronic Engineering (EEE)’s Centre for Optical Fibre Technology (COFT) and their collaborators in the United States have developed a novel way to fragment fibre-like materials into tiny, almost uniform internal segments or strips held in place within the fibre.

This approach allows them to manipulate the materials and blend them into the surroundings in a dynamic camouflage effect; increase their internal surface area for medical uses; and manufacture micro- and nanoparticles of the materials more easily for various purposes.

Led by Assistant Professor Wei Lei from the School of EEE, the findings showed that the method works on a variety of materials, including plastics, metals and glasses, and natural ones such as silk, ice and hair. It can produce particles ranging in size from nano-particles to ones that can be seen with the naked eye.

The innovation essentially makes use of a well-established process known as cold-drawing that has been used to produce synthetic fibres such as polyester and nylon. The researchers found that under certain conditions, some materials within the fibres naturally break apart into almost uniform pieces as they are being cold-drawn.
With its ability to easily produce large quantities of nano-particles, nano-rods and nano-wires, these findings could revolutionise disciplines ranging from optics to nanotechnology.

The research was first published in the Scientific Journal of Nature in 2016.

**Putting a brain on a chip**
The future looks bright for portable and wearable devices with the invention of a new smart chip that is infused with artificial intelligence by Associate Professor Arindam Basu and his team from the School of Electrical and Electronic Engineering.

The small and lightweight prototype, when mounted on a headgear, could help decode a monkey’s brain waves and predict how it wanted to move its fingers with 99.3 percent accuracy. This could pave the way for implants and portable devices to help paralysed people regain use of their limbs.

The chip could also enable surveillance cameras and sensors identify potential intruders and alert security. In addition, it can even empower health-monitoring devices to recognise when a person is about to suffer a heart attack or epileptic seizure and call for help.

The researchers exploited manufacturing imperfections to make their smart chip smaller, lighter and less power-hungry than counterparts on the market. Electronic devices consist of transistors that amplify electric currents or act as switches to start and stop various processes. While transistors are supposed to have specified sizes and properties, they invariably deviate to some degree because of design differences and manufacturing inconsistencies.

The NTU chip takes advantage of these unintended variations in the transistors’ threshold voltage, which determines their ability to produce current for a given input voltage. It uses mathematical formulas that multiply input signals such as brain waves, temperatures, pressure, sounds and images using the array of transistors with varying threshold voltages. This fleshes out similarities and differences among the signals. The chip can then better compare each signal to specified patterns.

Associate Professor Basu said the chip’s low power usage and compact size allows it to be embedded in sensors so that they can sort through raw data and transmit only refined or specified information.

Moving forward, the scientists are focused on developing further applications that will be integrated with their chip for brain-machine type interfaces and commercialisation purposes.

The team has also received S$250,000 from the Singapore-MIT Alliance for Research and Technology to further improve its prototype, including improved image recognition capabilities.
Blazing New Trails

Diagnosis by listening to the sound of light
Patients who suffer from stroke, shock and other brain diseases can benefit in the near future from POSTs (Photoacoustic Oxygen Saturation sensor) – a new invention by researchers from the School of Electrical and Electronic Engineering (EEE). Led by Associate Professor Zheng Yuanjin, this breakthrough could help doctors diagnose brain disorders in their early stages for better treatment outcomes.

There are typical clinical features of shock, such as fast heart rates, low blood pressures, altered mental status and reduced urine output, but many patients may not exhibit these features. Hence, the ability to accurately detect whether a patient is suffering from shock and provide the right treatment is crucial, especially in hospital emergency rooms, operating theatres and even intensive care units (ICUs).

Haemoglobin oxygen saturation of blood in the central veins (SvO₂), however, begins to fall early in shock even when blood pressures appear normal. The SvO₂ becomes lower than normal (<65 percent), reflecting a poor delivery of blood to oxygen-starved tissues, even when blood pressures appear normal. On the other hand, abnormally high levels of SvO₂ reflect a reduced ability of the tissues to metabolise oxygen. Thus, SvO₂ is an invaluable parameter for shock diagnosing.

Conventionally, SvO₂ can only be measured invasively using catheters in the right superior vena cava or in the jugular vein. The insertions of such catheters are by themselves risky, and only performed in selected patients. POSTs, a novel iPhone-sized sensor designed by researchers from the School of EEE, can detect SvO₂ accurately in a non-invasive manner.

Using POSTs, the sensor works by shining light of different colours on a patient’s neck and then “listens” to the resultant sound generated by the blood in the central vein to infer the SvO₂. The result is very accurate (about 2 percent) since oxygenated and de-oxygenated haemoglobin show distinct signatures in absorbing different colours of light and the generated sound waves could be accurately localised (<1 mm) with high signal to noise ratio.

“The results demonstrate that POSTs has great potential in non-invasive SvO₂ measurement and could be used in the ICUs in the near future for early shock detection. Our ultimate goal is to get our POSTs device to penetrate vast homecare market as well as the medicare market,” said Associate Professor Zheng.

The results demonstrate that POSTs has great potential in non-invasive SvO₂ measurement and could be used in the ICUs in the near future for early shock detection.
Nurturing Winning Collaborations

Greener maritime energy solutions at Sembcorp Marine Lab

NTU launched a new marine research laboratory, the Sembcorp Marine Lab that will develop innovative eco-friendly technologies for Singapore’s maritime and offshore industry.

Sembcorp Marine contributed a S$10 million endowment fund to develop ground-breaking solutions in fuel emission management, energy efficiency and green shipping.

It will also be equipped with the region’s first dual-fuel marine engine which is funded as part of the Naval Architecture and Marine Engineering Professorships programme at NTU – supported by the Singapore Economic Development Board (EDB).

The Sembcorp Marine Lab team, headed by Professor Lua Aik Chong from the School of Mechanical and Aerospace Engineering, will also be looking for alternative ways to retrofit and modify ship systems to ensure they can operate using both diesel and clean fuel such as liquefied natural gas. This will reduce harmful emissions and keep costs low.

Apart from this, researchers will be studying the emission levels of other clean fuels and the viability of using biofuels such as biodiesel in ship engines. As a result of the simple and cheaper options provided, ship companies will be able to go green and comply with the stringent emission regulations that will come into effect in 2020.

Moving forward, the new lab will also serve as a testbed, and work with various industry partners and government agencies such as the Maritime and Port Authority of Singapore (MPA) on maritime-related research projects.

Sembcorp Marine contributed a S$10 million endowment fund to develop ground-breaking solutions in fuel emission management, energy efficiency and green shipping.

Sembcorp Marine Laboratory
Reinforcing the CREATE Connection

Building on the success of various research partnerships in the past year, NTU’s Campus for Research Excellence and Technological Enterprise (CREATE) initiatives saw further collaborations in 2016.

TUMCREATE, a joint research programme established in 2010 between Technische Universität München (TUM) in Germany and NTU aims to develop the ultimate public transport system for Singapore. It seeks to introduce road transport solutions that provide high comfort and a positive travel experience, protect the environment and deliver maximum benefits to society and the economy.

In Phase I of TUMCREATE, which was from April 2010 to March 2016, researchers focussed on electromobility in megacities. The programme which is into its second research phase from April 2016 to March 2021, will focus on defining the ultimate public transport system for Singapore through a vision of public transport involving electric autonomous vehicles. Phase II comprises six research areas namely, Rapid Road Transport; Area-Interlinking Design Analysis; Individual Mobility Vehicles and Services; Design for Autonomous Mobility; Electrification Suite and Test Lab; and Sensing and Management for Agile Transport.

Out of the six programme Principal Investigators, four are from the College of Engineering. They are Professor Thambipillai Srikanthan from the School of Computer Science and Engineering, who is also NTU’s programme director for TUMCREATE, Professor Cai Wentong from the School of Computer Science and Engineering, Associate Professor Wong Yiik Diew from the School of Civil and Environmental Engineering and Associate Professor Ng Heong Wah from the School of Mechanical and Aerospace Engineering.

Meanwhile on the energy and water management front, a new joint research programme on Nanomaterials for Energy and Water Management (NEW CREATE) has been introduced. This new project aims to innovate advanced materials by pushing the scientific frontiers in energy harvesting, conservation and storage to meet the energy-water nexus needs through innovative manufacturing processes.

NEW CREATE is a joint research programme between the Hebrew University of Jerusalem (HUJ) and NTU that is funded by the National Research Foundation (NRF), under its CREATE programme.
NAFTEC will focus on building up expertise in Southeast Asia in the area of risk, benefit and sustainability assessments to support industries and regulatory agencies ensure safe and good quality food.

NAFTEC to tackle food security issues
Recognising that food security is an ongoing problem, the NTU Food Technology Centre (NAFTEC) has been established to develop innovative solutions that support science-based improvements for food technology optimisation in Singapore and the region.

NAFTEC will focus on building up expertise in Southeast Asia in the area of risk, benefit and sustainability assessments to support industries and regulatory agencies ensure safe and good quality food.

The team at NAFTEC is led by Professor Jorgen Schlundt and Professor William Chen from the School of Chemical and Biomedical Engineering, as its director and deputy director respectively.

The centre will have more than 20 full-time researchers and scientists working on projects, including the interdisciplinary investigation of anti-microbial resistance in microorganisms in food and patients in Singapore, as well as the region.
Blazing New Trails

In addition, the health effects of microorganisms in the human gut, how to improve their composition through our food – an area which could potentially help prevent many of the ‘life-style’ diseases affecting especially the elderly – will also be explored.

Designated as the Asia-Pacific Economic Cooperation (APEC) Centre for Sustainable Development in Agriculture and Fishery Sectors, NAFTEC will soon conduct research on sustainable solutions and scientific evaluations of food production systems in support of APEC’s 21 member countries moving forward.

NAFTEC has started working with several Singapore agencies, including the Ministry of Health, the Agency for Science, Technology and Research, Tan Tock Seng Hospital, the Agri-Food and Veterinary Authority of Singapore and the National Environment Agency.

On the international front, it has entered into collaborations with the World Health Organization, United Nations Food and Agricultural Organization, the United States Food and Drug Administration, the University of New South Wales, and other universities in Europe and USA.

**Enabling Smart Nation solutions at SPIRIT**

NTU College of Engineering has recently set up the Centre for Smart Platform Infrastructure Research on Integrative Technology (SPIRIT) as a translational research and development institute to design future-proof platform and infrastructure for enabling Smart Nation applications.

It will serve as a one-stop-shop with a wide range of engineering competencies. This includes systems research and artificial intelligence to develop a resilient and scalable smart platform infrastructure with text and video analytic capabilities as well as wireless sensor networks.

Here, cutting-edge systems that research, design and build Smart Systems platform, including servers, network and storage and the required software environment, will be applied to enable the development of Smart Nation applications.

Foundation and supported by the Smart Nation Programme Office, GovTech and other user agencies, is led by Professor Lam Kwok Yan from the School of Computer Science and Engineering and Professor Yoon Soon Fatt from the School of Electrical and Electronic Engineering.
Enhancing lives at Delta-NTU Corporate Laboratory for cyber-physical systems

A S$45 million Delta-NTU Corporate Laboratory for cyber-physical systems has been set up at NTU. The laboratory aims to develop smart technologies that will enhance everyday lives, enable better learning and advance manufacturing processes.

Jointly developed by NTU and Taiwan’s Delta Electronics, it will focus on developing cyber-physical systems, ranging from large infrastructure systems such as water and power distribution to emerging consumer systems which includes the Internet-of-Things, an ever-growing network of physical objects and systems connected to the Internet.

SPIRIT will also serve as a platform to connect several ecosystems such as the government, academicians and industry experts. It will assist public sector agencies in converting new ideas into innovative proof-of-concept solutions by leveraging on existing R&D capabilities and technical competencies of NTU researchers. SPIRIT will also help validate and enhance such solutions as well as enable full-scale development and deployment by working with industry partners to accelerate the commercialisation of Smart Nation solutions.

**DSAIR at NTU – a world leader in data science and innovations**

In this era of big data where there is a huge volume of digital information, it is imperative to be equipped with capabilities to extract knowledge and insights from large data, and turn them into actionable items. This has led to the growth in interest and demand in two emerging fields – data science and artificial intelligence (AI) – both of which are at the core of big-data analytics and could yield game-changing technologies.

The Data Science and Artificial Intelligence Research Centre@NTU (DSAIR) has been established to seize opportunities in these fields and also support the Singapore Government’s efforts in becoming a Smart Nation.

Led by Professor Ong Yew Soon from the School of Computer Science and Engineering and Professor Chee Yeow Meng from the School of Physical and Mathematical Sciences, DSAIR aims to develop cutting-edge technologies in data science and AI; translate data science and AI research into commercial impact; train the next generation of data and AI scientists; and solve challenges, find efficiencies, and innovate to support the Smart Nation efforts.
Blazing New Trails

Headed by Professor Xie Lihua from the School of Electrical and Electronic Engineering, the joint laboratory will have more than 80 researchers and staff, including NTU Ph.D. students when running at full capacity. They will be working together with scientists from the Delta Research Centre, focusing on four key research areas, namely Smart Manufacturing; Smart Learning; Smart Living and Smart Commercialisation.

The new joint lab is supported by the National Research Foundation under its Corporate Laboratory@University Scheme, which funds key corporate laboratories set up through public-private partnerships.

NTU has partnered transport operator Singapore Mass Rapid Transit (SMRT) to establish a S$60 million joint laboratory that will provide technology-driven solutions to keep rail systems moving quickly and efficiently.

**Driving urban mobility**

NTU has partnered transport operator Singapore Mass Rapid Transit (SMRT) to establish a S$60 million joint laboratory that will provide technology-driven solutions to keep rail systems moving quickly and efficiently.

Known as the SMRT-NTU Smart Urban Rail Corporate Laboratory, it will focus on two research tracks – development of better monitoring and detection systems to fix potential problems, and devise prediction methods and analytical tools to aid in pre-emptive maintenance.

Using real-time data sensors, the first track allows components to be repaired or replaced immediately, thus reducing disruptions and escalation of technical issues. The second track is centred on enhancing the reliability of existing rail assets, reducing potential problems and ensuring all components are performing.

Professor See Kye Yak from the School of Electrical and Electronic Engineering, who is also the Director of the SMRT-NTU Corporate Laboratory, hopes that this joint laboratory will nurture engineering specialists in the rail industry who will create solutions that are used globally.

It is also the first of its kind under the National Research Foundation's Corporate Laboratory@University Scheme to focus on rail transport capabilities.
The laboratory will also provide training opportunities for more than 100 undergraduates, 35 graduate students and 60 researchers across a broad range of specialties.

To further drive urban mobility, the Transport Research Centre (TRC@NTU) was established in collaboration with the Land Transport Authority of Singapore (LTA). This collaboration will further mobilise research for the future of Singapore’s land transport system and create a well-connected land transport system with less reliance on cars.

TRC@NTU is headed by its Co-Directors, Professor Tan Kang Hai from the School of Civil and Environmental Engineering, Dr. Evan Gwee and Dr. Leong Wai Yan from LTA. This research centre is under the purview of its Executive Committee whose Co-Chairs are Professor Lam Khin Yong, the Chief of Staff and Vice President (Research) of NTU and Mr. Lam Wee Shann, the Group Director (Technology and Industry Development) of LTA.

TRC@NTU will emerge as a distinctive, multidisciplinary platform that brings NTU professionals of various backgrounds to work together with LTA on research and technical trials for innovative technologies in the transport industry.

In 2016 alone, NTU through TRC@NTU had in place 16 research grants amounting to S$7 million from LTA covering various transport tracks, including active mobility; infrastructure design and engineering; geotechnical and tunnelling engineering; MRT/rail system inspection and condition monitoring; transportation and road operation; and architecture.

One of the research projects at TRC@NTU: Geographic Information System (GIS) based life cycle durability assessment of underground infrastructures.
Our people are forward thinkers, passionate to make a difference for the community, nation and the world. At NTU College of Engineering, our trailblazers are equipped with the best support and resources as they uncover and pioneer new possibilities to shape a better tomorrow.
OUR PEOPLE:
Talent, Passion and Spirit of Excellence

At NTU College of Engineering, we continue to cultivate exceptional thinkers and researchers to stay ahead of the curve. Our people are committed to make a difference and bring lasting change to the lives of people around them. They explore new fields that transcend boundaries, and venture beyond classrooms to gain different perspectives and life experiences in pursuit of excellence.
Inspiring Alumni

At NTU College of Engineering, our students receive a holistic education that equips them with the right combination of skills, ranging from soft skills to technical ones to face the real world. Our versatile programmes have introduced leaders across wide-ranging fields. These programmes have sparked an inner light for many students while they pursue and shape their future.

Be it in a professional or a social capacity, these individuals have gone on to prove their extraordinary capabilities, made more evident with their spirit of giving to the community around them.

Here, we catch up with two alumni whose efforts have redefined the future of engineering, introducing new concepts and also, giving back to society. We hope you will be inspired by their stories.
Inspiring Alumni

Von Lee Yong Miang
A step-by-step approach in realising ambitions

Mr Von Lee (far left), Chairman of Expand Group of Companies, presenting the cheque to Prof Lee Sing Kong (third from left), NTU’s Vice President (Alumni and Advancement), witnessed by Mr Inderjit Singh (second from left), NTU Board of Trustees member and Mr Victor Tay (far right), NTU’s Chief Development Officer

Who would have thought that one of CoE’s students, who 20 years ago was a campus rookie scrambling around from classes to part-time jobs, would today be a leading entrepreneur in Singapore?

Von Lee Yong Miang, Founder and Chairman of Singapore’s multimillion dollar Expand Group of Companies, graduated as a civil engineer from NTU’s class of 1995 and he founded Expand Construction in 2000. Under his guidance, the company grew and is today amongst the leaders in Singapore’s construction industry, with more than 590 employees and a number of award-winning developments and projects.

In fact, he is also responsible for some of Singapore’s most iconic structures such as the Supertrees at Gardens by the Bay, the Lee Kong Chian Natural History Museum and the Marina Bay Waterfront Promenade.

According to Von, the education he received at NTU set a strong foundation in the area of technical knowledge and soft skills which he has applied in business. Armed with engineering know-how and project management skills, he successfully steered his company in the construction industry.

Through his rising success, Von has also found a way to grow his other passion by helping the less fortunate. He contributed S$1 million to NTU to start a new endowment fund to benefit needy students. This was further matched by the Singapore Government, bringing the total endowment to S$2.5 million.

The new Von Lee Yong Miang Bursary Fund will provide financial support to undergraduates pursuing any engineering field of study at CoE. It will fund up to 10 awards per Academic Year, each comprising a generous sum of S$10,000.

“I received financial help from NTU during my university days and now as an alumnus, I’m ready to help my juniors in a similar situation so that they can focus on their studies and later, pay it forward,” said the award-winning developer.

On that note, he also advised students to take on their ambitions, step by step. “Focus on excelling in the little things first, and naturally, bigger achievements will come.”

Ted Chen Chiu-Hao
From circuit boards to Forbes 30 under 30 Asia list

Ted Chen Chiu-Hao liked playing around with microcontrollers, resistors, relays and putting things together on a circuit board since young. His interests led him to NTU’s School of Electrical and Electronic Engineering (EEE) where he participated in many start-up events, hackathons and business workshops organised by NTUitive, the university’s innovation and enterprise company.

The co-founder and product architect of Evercomm Uni-Tech Singapore, graduated from NTU in 2012 with a Bachelor of Engineering in Electrical and Electronic Engineering. Later in 2015, Chen obtained his Master of Science in Technopreneurship and Innovation (M.Sc. TIP), also from NTU.

During his time as a researcher at EEE, he met Ko Ko and together they set up EverComm which has been accredited as an innovative energy analytics company by Infocommunications Media Development Authority (IMDA) of Singapore. It was also during this time that he learnt a lot about research commercialisation and the implementation of cutting-edge research by working with various multinational companies.
“CodeXtreme opened up the doors for us to apply for R&D grants, working at the School of EEE taught us how to translate research into commercial product, and NTUitive gave us the support and guidance needed to embark on the start-up journey.”

Together, they worked with Professor Gan Woon Seng from the School of EEE who also encouraged them to participate in more hackathons to sharpen their programming skills.

“When Ko Ko and I won first place at CodeXtreme App — a national level hackathon supported by IMDA — all the dots suddenly connected. CodeXtreme opened up the doors for us to apply for R&D grants, working at the School of EEE taught us how to translate research into commercial product, and NTUitive gave us the support and guidance needed to embark on the start-up journey,” explained Chen on his entrepreneurial journey.

Chen even started the NTU Green and Sustainable Technologies Society during his undergraduate days. The society seeks to groom students to be leaders for the green industry. Notable green solution projects include spearheading the creation of an electric-bicycle system inside NTU, with the Society successfully obtaining projects worth S$50,000 from its partner organisations.

According to Chen, the engineering education programme at NTU provided him with many opportunities to interact with the industry. The programme set the basic technical foundation to help him undertake and manage this development in his career. In addition, he also learnt a lot during his professional internship, and it gave him the upper hand whenever he participated in local hackathons.

Today, EverComm helps manufacturers reduce energy wastage by providing energy management and analytics solutions. Once the data from energy sources are collected and validated, EverComm analyses this energy usage and output data to recommend the most efficient equipment settings for the manufacturer.

EverComm also works closely with NTU on various research projects, and explores sustainable urban planning with Surbana Jurong. It also pioneers Internet of Things and industrial solutions with NXP and GLOBALFOUNDRIES. As at March 2016, EverComm had accumulated over US$3.4 million in energy savings, while the company had generated over US$1 million in total revenue. EverComm was voted the favourite of four start-ups at the Lion’s Den event at the 8th World Entrepreneurship Forum. Chen was named in Forbes’ inaugural 30 under 30 Asia list (Manufacturing & Energy category). He was also awarded the Nanyang Outstanding Young Alumni Award by NTU in 2016.

On his success, he said, “I can only say we are extremely lucky to be in Singapore. The ecosystem is surrounded by amazing people and mentors with great support infrastructure.”

Moving forward, Chen and his team are focused on expanding in Asia. Their goal is to help more companies and government identify the most cost-efficient way to achieve their sustainability targets. He also believes that young engineers should pursue urgent global challenges such as climate change, super viruses and more as these problems can impact the quality of life of people, now and in the future.
We value the contributions of our outstanding faculty members from various backgrounds who solve real-world challenges and add value to the social, economic and environmental development of the communities around us.

**Professor Wang Rong**

**Delivering innovations that improve quality of life**

Ranked among the top 25 leading water researchers in the world by Lux Research, Professor Wang Rong and her team recently broke new ground with the development of a thin film composite hollow fibre membrane which can reduce membrane fouling and scaling in forward osmosis processes. This will also reduce energy usage in the water reclamation and recycling processes. The Public Utilities Board (PUB), Singapore’s national water agency has also identified the commercial potential of this latest breakthrough. Trials are currently being conducted with industry partners for the treatment of processed water in the oil and gas industry as well as for application in the food and beverage industry.

“The thirst for clean water is very real. With the sustainability of potable water becoming a global issue, our research looked into alternatives which are renewable, sustainable and accessible to all. We worked on novel membrane technologies for effective, efficient water production and water reclamation at lower energy intensities.”

For her contributions in developing sustainable water solutions, Professor Wang was awarded the Alternative Water Resources Prize at the Prince Sultan Bin Abdulaziz International Prize of Water (PSIPW) 7th Award in 2016. Established in 2002, PSIPW is a world-leading biennial award that recognises scientists, researchers and inventors around the world for their innovative scientific researches in addressing the global issue of water scarcity.

On winning her award, she says, “I am very grateful that the Prize Council recognised novel membrane technologies and cutting-edge water research which will contribute to the sustainable availability of potable water. I believe that this will inspire the future generation of professionals to continue developing innovative alternative resources that improve the quality of life of people across the world.”

Guided by a strong appetite for discovery, our distinguished team has played a major role in the many advances that have shaped the future of this nation.
Professor Wang, the first Chinese female engineer to receive this award is also the Chair for the School of Civil and Environmental Engineering (CEE) at NTU. She believes that it is important to nurture CEE students to be responsible and competent individuals through the flexible and broad-based curriculum. By inculcating the spirit of lifelong learning in undergraduates, they can then realise their maximum potential in their engineering or maritime professions.

Since joining NTU in 2008, Professor Wang who is also the Director of Nanyang Environment and Water Research Institute - Singapore Membrane Technology Centre (NEWRI-SMTC) has produced 140 high-impact journal publications and over 20 patents. One of the patents led to the set up of a spin-off company while another was licensed for commercialisation.

Under her leadership, NEWRI-SMTC, that was set up in 2008, has become a global leader in membranes and sustainable water with over 80 full-time researchers.

Professor Wang is currently working on aquaporin-based biomimetic hollow fibre membrane, which has been proved to be able to reduce the energy consumption significantly when applied in water reclamation process. A memorandum of understanding (MOU) was signed with Hyflux, a global leading water treatment specialist, to scale up the membrane production in 2017 with the support from Singapore’s Economic Development Board (EDB) and PUB.

“I am very grateful that the Prize Council recognised novel membrane technologies and cutting-edge water research which will contribute to the sustainable availability of potable water. I believe that this will inspire the future generation of professionals to continue developing innovative alternative resources that improve the quality of life of people across the world.”

From left: PSIPW Chairman H.R.H. Prince Khaled Bin Sultan Bin Abdulaziz and United Nations Secretary-General Ban Ki-moon presented Professor Wang Rong with the Alternative Water Resources Prize. Far right is Saudi Arabia’s Minister of Environment, Water and Agriculture Abdulrahman al-Fadhli.

Photo credit: PSIPW
Driven to help data centre operators make well-informed decisions, Associate Professor Wen Yonggang’s award-winning Cloud3DView has been touted by the industry as an innovative solution to address the critical challenges of tomorrow’s data centre.

Inspired by a magician’s act to move contents across multiple iPhone screens at a TED talk, Cloud3DView aims to transform data centre operations from command line interface or web interface to the more intuitive 3D interface, equipped with graphic visualisation of the outcomes of operational actions.

This will not only reduce the possibility of human errors in data centre operations, but also allow operators to experiment new technologies and best practices in a 3D emulator to visualise their outcomes before deploying them in a physical data centre. Cloud-based, these solutions also enable mobility and ubiquity in data centre operations.

“Throughout my career, I have been advocating and practising use-inspired research. I work on real-world problems that carry immediate socio-economic importance and impact. In this case, curbing energy consumption at almost no upfront cost.” Intent on optimising performance, his decision to create a ‘wow’ product was spot on, as Cloud3DView has gone on to win several awards, including the 2016 ASEAN ICT Awards (Gold) and the 2015 Datacentre Dynamic Asia Pacific Award (the ‘Oscar’ award of data centre industry). The team also won the 2013 ASEAN ICT Awards (Gold) for their multi-screen cloud social television project.

Nevertheless, the road to success has been paved with challenges. “The most difficult thing in developing Cloud3DView has been to maintain our confidence that the system can be developed with existing technologies. Silicon Valley experts believed that it could be a transformative technology, but had concerns that it might take 10 to 15 years before enabling technologies would mature.” “Guided by the pace in technology development and constant discussion with industry practitioners, we designed a ‘science-fiction’ research idea and delivered something that exceeded even our own imaginations! It was really a team achievement – my students, research staff, internal and external collaborators as well as industry partners.”

Winning honours at global platforms has not slowed down Associate Professor Wen. In fact, he is currently working on two system projects. The first project is focused on the adoption of Artificial Intelligence (AI) technology for data centre management. This project is aimed at developing the world’s first humanless data centre for tropics and saving energy consumption by up to 40 percent.

Meanwhile, the other project is focused on leveraging on emerging wearables to develop personalised thermal comfort models. These models will be used in office buildings to improve energy efficiency and insist behavioural changes for building occupants.

Associate Professor Wen, who is also the Assistant Chair for Innovation at NTU’s School of Computer Science and Engineering (SCSE), says: “My main responsibility is to develop innovative strategies that will empower our students and faculty members to bring our technologies into life in Singapore. Once the SCSE innovation lab renovation is completed, we will introduce programmes that encourage student entrepreneurship, industry innovation and technology adoption. I believe that this centre will be a hotbed of entrepreneurial activity, bringing together researchers with diverse skill-sets to create new ways to turn ideas into solutions.”
Assistant Professor Marcos

A picture speaks a thousand words

Recognising that students learn more effectively when they are excited about a subject, Assistant Professor Marcos created a Facebook page that linked YouTube videos to help students understand and visualise the concepts learnt during lectures. He also did this to create a meaningful platform to engage them in the process of learning.

Through the Facebook page, students were also given updates on upcoming quizzes, lectures and even had their doubts answered through private messages and comment posts.

This Facebook page has since helped many students comprehend difficult concepts, relearn lecture contents and increase discussion amongst students with the additional resources provided. From just a social networking site, it has emerged as an important learning tool for many of Assistant Professor Marcos’ students.

According to Assistant Professor Marcos, it is essential that students see a clear link between theories, concepts and their use in the real world so that they are able to see a bigger picture.

He explains, “The teacher plays an important role in making the learning process fun and exciting. Illustrating difficult concepts using physical examples and relating it to something students are familiar with will encourage them to enjoy the subject.”

Assistant Professor Marcos’ efforts in engaging and teaching students via social media has garnered the attention of many as he was also previously honoured with various awards such as Dr. S.K. Leung Excellence in Teaching Award 2013, Nanyang Education Award (School) 2015, Nanyang Education Award (College) 2016 and the John Cheung Social Media Award 2016.

The John Cheung Social Media Award highlights best practices in the use of social media for teaching. It recognises and rewards innovative teaching ideas that promote and demonstrate the educational benefits and appropriate use of social media.

Aside from teaching, Assistant Professor Marcos is currently working with his team on the portable rapid on-board microfluidics lab-on-chip device for rapid detection and characterisation of the number of live and dead microbes in ballast water. The project will significantly reduce threats of foreign invasive marine species attacks. This, in turn, will help maintain the marine ecology of Singapore and other destination ports.

Guided by his personal motto, ‘If we are better today than yesterday, that’s progress,’ Assistant Professor Marcos will continue to nurture the students of NTU by sharing with them his skills and knowledge, inspiring them to become outstanding engineers and scientists in the future.
Faculty Honours and Awards

NRF Investigatorship Awards
Professor Chen Xiaodong and Professor Madhavi Srinivasan, both from the School of Materials Science and Engineering, received the NRF Investigatorship Awards in 2016.

The NRF Investigatorship brings together established, innovative and active researchers to address challenges and capitalise on new opportunities through ground-breaking, high risk research. The Award has been designed to assist Principal Investigators who have demonstrated their ability to introduce ground-breaking initiatives and provoke new approaches that have allowed them to stand out as leaders in their respective areas. Upon winning the award, the recipient will receive up to S$3 million over a period of five years to pursue new research that will generate new knowledge.

Temasek Laboratory’s Hardware Assurance Team wins Defence Technology Prize 2016 Team (R&D) Award
The Hardware Assurance Team from Temasek Laboratories@NTU won the prestigious Defence Technology Prize 2016 Team (R&D) award by the Ministry of Defence (MINDEF). The team was recognised for its outstanding contribution in the areas of defence science and technology.

Led by Professor Gan Chee Lip, School of Materials Science and Engineering (MSE) and Associate Professor Gwee Bah Hwee, School of Electrical and Electronic Engineering (EEE), the team comprised researchers from the School of EEE as well as the Microelectronics Failure Analysis Lab from the School of MSE.

This multidisciplinary team has introduced various physical and circuit analysis techniques and software, even advanced integrated circuit chips to protect against hardware Trojans in the last 10 years. To achieve this, they conducted new sample preparation recipes, efficient high-resolution imaging techniques and processing, including automated circuit analysis.

The Defence Technology Prize fosters and encourages technological innovation and excellence amongst scientists and engineers by giving recognition to outstanding technological contributions to Singapore’s defence capability.

Outstanding Faculty

National Research Foundation (NRF) Fellowship Scheme
Associate Professor Xavier Bresson from the School of Computer Science and Engineering was conferred the NRF Fellowship.

The NRF Fellowship Scheme is a competitive programme that seeks to attract, recruit and root outstanding young scientists from around the world to conduct independent research in all areas of Science and Technology in Singapore, over a five-year period. Each Fellow is provided with a research grant to support projects that exhibit high likelihood of a research breakthrough.

Outstanding Faculty
Institute of Electrical and Electronics Engineers (IEEE) Fellowships
Five faculty members from NTU College of Engineering were recently elected as the Institute of Electrical and Electronics Engineers’ Fellows in 2017, the highest number ever achieved by NTU.

The Fellowship, which is the highest grade of IEEE membership, is regarded by the international engineering community as a prestigious honour that recognises individuals with an extraordinary record of accomplishments in any IEEE field of interest.

The five newly elected IEEE Fellows are:

**Associate Professor Chau Lap Pui**  
School of Electrical and Electronic Engineering  
Contributions to fast computation algorithms for visual signal processing

**Associate Professor Dusit Niyato**  
School of Computer Science and Engineering  
Contributions to resource allocation in cognitive radio and cellular wireless networks

**Associate Professor Shen Zhongxiang**  
School of Electrical and Electronic Engineering  
Contributions to 3D frequency selective structures and slot antennas

**Professor Su Guaning**  
President Emeritus  
School of Electrical and Electronic Engineering  
Leadership in defence technology and management of educational institutions

**Associate Professor Josep Pou**  
School of Electrical and Electronic Engineering  
Contributions to multilevel converters and renewable energy conversion
Outstanding Faculty

Full Professorial Promotions
Congratulations to our colleagues who were promoted to Full Professorship.

Professor Miao Chunyan
School of Computer Science and Engineering

Professor Wang Xin
School of Chemical and Biomedical Engineering

Professor Hng Huey Hoon
School of Materials Science and Engineering

Professor Huang Guangbin
School of Electrical and Electronic Engineering

Professor Madhavi Srinivasan
School of Materials Science and Engineering

Professor Gan Chee Lip
School of Materials Science and Engineering

Professor Pang Hock Lye, John
School of Mechanical and Aerospace Engineering

Professor Tan Ah Hwee
School of Computer Science and Engineering

Professor Wang Peng
School of Electrical and Electronic Engineering

Professor Tan Ah Hwee
School of Computer Science and Engineering

Professor Wang Xin
School of Chemical and Biomedical Engineering
Newly Hired Faculty Members
The College recruited a total of 35 faculty members in the year of 2016.

Legend
CEE: School of Civil and Environmental Engineering
EEE: School of Electrical and Electronic Engineering
MAE: School of Mechanical and Aerospace Engineering
MSE: School of Materials Science and Engineering
SCBE: School of Chemical and Biomedical Engineering
SCSE: School of Computer Science and Engineering

Basman Mohamed Nabil
Ahmed Khairat Elhadidi
Senior Lecturer, MAE
Ph.D., University of Notre Dame, USA, 2003
Associate Professor, Cairo University, Egypt, 2010 – 2016

B.V.R. Chowdari
Professor, MSE
Ph.D., Indian Institute of Technology Kanpur, India, 1968
Executive Director, National University of Singapore, Singapore, 2007 – 2016

Chan Wai Lee
Assistant Professor, MAE
Ph.D., University of Michigan, USA, 2016
Visiting Scholar, Stanford University, USA, 2016 – 2017

Dang Thuy Tram
Assistant Professor, SCBE
Ph.D., Massachusetts Institute of Technology, USA, 2012

Foo Yi Shyh Eddy
Lecturer, EEE
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Exceptional Students

Driven by their intelligence, creativity, innovative spirit and passion for learning, our students have come together from different backgrounds to join the quest towards gaining intellectual excellence.

We are nurturing the next generation of leaders to challenge conventional thinking by bringing lab bench results to life through actions that will create lasting change and enrich human life.
Although the team encountered many difficulties during the competition, they showed tenacity, determination and the spirit of innovation through repeated experiments and exploration of alternative methods.

NTU Students Clinch Sembcorp Water Technology Prize 2016
An exciting taste of the real-world careers pushed Joshua and Jing Yaw to fight and win!

NTU's team of two students, Oh En Yao Joshua and Goh Jing Yaw, walked away as overall champions at the Sembcorp Water Technology Prize (SWTP) 2016.

Both Joshua and Jing Yaw, third year students from the School of Civil and Environmental Engineering, impressed the panel of judges with their persuasive presentation that utilised key experimental data, graphs and reasoning.

The NTU team competed against 14 teams (28 students) from various Polytechnics, Institutes of Technical Education and Universities to build and run the best-performing, most efficient membrane bioreactor (MBR) system that reduced energy consumption. The winning team was presented a cash prize of S$5,000 by Sembcorp Group President & CEO, Mr Tang Kin Fei. They also won internship opportunities with Sembcorp Industries.

The competition, themed “Optimisation of Hollow Fibre Membrane Bioreactors”, comprised mainly two phases namely training and experimental. In the first phase, participants were taught the principles of membrane filtration and how to build a prototype membrane reactor by assembling hollow fibres into a single module. Subsequently, participants were required to brainstorm, plan, design and set up own experiments which will support their hypothesis for their proposed operational parameters.

The Sembcorp Water Technology Prize 2016 is an annual nationwide competition sponsored by Sembcorp and supported by PUB, the national water agency, that aims to give students a taste of what it is like to be water engineers for a day.
Semcorp-EMA Energy Challenge 2016
Powering change

A team of undergraduates from the School of Electrical and Electronic Engineering emerged as first prize winners under the Higher Education Institute Category and Overall Champions for all categories at the annual Semcorp-EMA Energy Challenge 2016.

The team, consisting of Lim Zhi Wei, Dylan Tan, Tan Yong Chin and Norvin Setiawan, all third year students, fought hard against the other 24 teams from various Institutes of Technical Education, Polytechnics and Universities. They were also given internship opportunities by Semcorp.

The Challenge was divided into two phases. In the first phase, the teams were invited to attend a one-day tour at Semcorp to understand and learn about its power plants at Pulau Ubin and Jurong Island. Besides gaining on-site experience on the workings of the newly-invented co-generators, they also experienced a real-life simulation focused on building and managing a reliable, profitable power plant while at the same time, ensuring sustainability of the overall environment.

Based on the software simulation, the teams in the second phase were required to achieve the highest score possible, based on the three main criteria – profitability, environmentally sustainable and reliability – within just 90 minutes.

The event provided the students with in-depth insights on the evolution of power and energy – past, present and future. It was also an ideal platform for them to interact with industry leaders and build a stronger network for their future careers.

The Semcorp-EMA Energy Challenge was part of a larger convention, the Energy Innovation 2016. This is the second edition of the convention, co-organised by the Energy Market Authority, National Climate Change Secretariat and National Research Foundation.

The goal of the challenge was to encourage collaborations among industry players, researchers and government bodies to grow local capabilities to meet Singapore’s energy and low carbon objectives.
NTU’s Renaissance Engineering Programme (REP) Students Bridge Language Barriers

Promoting social change through language

Ladon, a crowdsourcing platform that enables qualified language assistants and translators to help the social workers communicate with people who are non-English speaking, was co-founded by Ho Anh-Thu and her REP friends during their study stint in the University of California, Berkeley (UC Berkeley).

A wide variety of clients such as social workers, medical service providers and teachers can call Ladon’s number and be directly connected with Spanish, Cantonese, Mandarin, Vietnamese, and Arabic language assistants. Ladon’s aim is to make social services more accessible for immigrants and other individuals with limited English proficiency.

The project won first place in the 2016 Social Entrepreneurship Challenge Lab at UC Berkeley and the Resolution Social Venture Challenge at the Clinton Global Initiative University (CGIU) 2016, a gathering of more than 1,100 students.

Ho subsequently won the coveted Westly Prize 2016 for the Ladon project. The Westly Prize awards US$20,000 to talented young innovators under the age of 29 who have created novel solutions to overcome community challenges at home or around the world.
Credits and Thank You

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