INFOCUS

ISSUE 33

HKUST ENGINEERING SPRING 2021

Thinking Ahead

Accelerating Smart Hong Kong

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

工學院
SCHOOL OF ENGINEERING

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HKUST Engineering
In Focus Magazine
sengpr@ust.hk
(852) 2358 5917
https://seng.ust.hk/node/2914

Published by:
Communications and External Affairs
School of Engineering
The Hong Kong University of Science and Technology

Editors: Diana Liu, Dorothy Yip
Contributing Editor: Sally Course
Designer: Kingsley Lau

hkustengineering
HKUST-SENG
seng.ust.hk

Moving onward and upward

During a year of change to established practices due to the COVID-19 pandemic, I am very happy to note that, despite all the challenges, the overall outcomes for the School of Engineering's education and research have been inspiring. Indeed, thanks to the tremendous efforts of the School's faculty, students, and alumni, leaps in learning have taken place through adapting to the extraordinary times.

Our effective expansion of mixed-mode teaching – a blend of online and in-person delivery – has opened up many more possibilities for delivery and reach of our classes. We have further extended our exploration of virtual labs through the creation as well as adaptation of leading-edge visualization tools and equipment. Meanwhile, the adoption of e-learning technologies and pedagogies means physical presence on campus is no longer always required, widening the potential for recruitment of local and non-local intake of top minds unable to continuously attend in-person.

Nor have we been standing still with our degree programs. The pioneering initiative of an extended major option for undergraduates, termed "Engineering + X" is one key move. Our first "X" will be artificial intelligence (AI), enabling engineering students to gain an early step-up on this significant and rapidly expanding field as it relates to their chosen engineering major. That students realize the great opportunity this provides can be seen in the overwhelming numbers applying for the option. Moreover, looking ahead, "X" can refer to other areas of emerging importance, such as digital media.

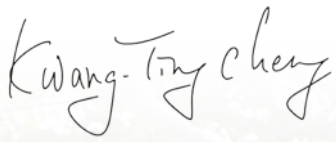
Research advances by faculty at all stages of their careers, not only senior members, have also continued to draw widespread attention as well as contribute to addressing COVID-19. I am delighted that two new large-scale research centers are now set to add such reach.

Focused on integrated circuits to accelerate AI computations and construction robots respectively, and involving international partners, these centers stand out through their integration of basic and downstream development and the training of talents with understanding and skills beyond their individual research roles.

They will thus provide a living example of the linkage between discovery, innovation, and social impact – and bring together these key but often not fully connected elements of a university's role: a focus on basic research in a way that other drivers, such as government and industry, do not; and the translation of that research to society to create impact.

All these developments are a clear indication of the School's resilience, flexibility, innovative spirit, and passion. In the most testing of times, these qualities, combined with an expansion of facilities and opportunities, including our education innovations, research centers, and the University's new Guangzhou campus, have created truly exciting choices for the future that otherwise would not have been possible.

This is certainly a win-win-win situation for young aspiring engineers, HKUST, and society as a whole.



Prof. Tim CHENG Kwang-Ting
Dean of Engineering

Far-sighted R&D centers spur IC and robotics innovation

HKUST is now actively recruiting for two major research centers that are seeking to produce breakthroughs and applications focused on integrated circuits to accelerate artificial intelligence chips and systems, and construction robots, respectively.

The large-scale centers, led by the School of Engineering, combine state-of-the-art research conducted together with international partners to drive cutting-edge innovation. In addition to generating publications in top journals, the centers will move beyond this to produce artifacts and demonstrations of technology-transfer readiness for industry, that is, mid-stream to downstream in the research and development process.

The two centers are creating an integrated research pipeline from discovery to downstream development.

Led by eminent School faculty, many other engineering faculty are being engaged in the endeavors, with more researchers, innovators, and engineers being sought globally at various levels.

“The idea is to take a focused area and build a pipeline from research all the way to downstream,” Dean of Engineering Prof. Tim CHENG said. “So the talents we recruit will have the skill sets covering the entire vertical ecosystem. Although different people will focus on different stages of the research development, they will be vertically integrated to work together.”

The centers thus offer the School a unique opportunity to combine its globally leading research efforts, build a pool of talent in these two highly significant areas for future technologies, and deliver social impact, Dean Cheng added.

Going for gold

A co-operative endeavor by School of Engineering researchers and the Hong Kong Sports Institute to enhance the performance of Hong Kong’s high-riding international cycling team is gearing up for its most significant global showcase to date at the Tokyo Olympics this summer, if the sporting event still goes ahead amid the latest COVID-19 uncertainties.

The two-year A. Kwok Sports Aerodynamics Science Initiative Project, launched in 2019, involves cutting-edge research and technology led by Prof. ZHANG Xin, Swire Professor of Aerospace Engineering and Chair Professor of Mechanical and Aerospace Engineering, and the Institute’s elite cyclists, including star team member Sarah LEE Wai-Sze. It is supported by the Hong Kong government’s Innovation and Technology Fund and a HK$6 million donation from Sun Hung Kai Properties Executive Director Mr. Adam KWOK Kai-Fai.

Prof. Zhang and his team have combined an advanced aerodynamic rig with computational fluid dynamics based on Formula One racing car technology to hone the cyclists’ performance through their posture and clothing, among others.

Top star Sarah Lee is among those participating in a cutting-edge sports research initiative with HKUST to boost the Hong Kong cycling team’s performance. She won a gold medal in the women’s sprint at the first UCI Track Cycling Nations Cup at the Hong Kong Velodrome in May 2021.

Ms. Lee said it had been exciting to be part of the initiative, which included wind tunnel tests and had helped boost the team’s potential to succeed.

Prof. Zhang also said that the researchers would continue to work closely with the Institute and its sports science team in the future to apply further research to competitions and the technology to other sports.

HKUST(GZ) Founding President appointed

In a key step forward, Prof. Lionel NI Ming-Shuan has been appointed Founding President of the new Hong Kong University of Science and Technology (Guangzhou) (HKUST(GZ)) campus now under construction and scheduled to open in September 2022.

The appointment will take effect following official approval from the Ministry of Education for the formal establishment of HKUST(GZ).

Prof. Ni, who became Provost of HKUST at the Clear Water Bay campus in 2019, is a highly accomplished computer science and engineering scholar of international recognition and a recipient of several of Mainland China's leading research accolades.

He is also a respected senior academic administrator, with many years of experience at HKUST and elsewhere. Former roles include heading the School of Engineering's Department of Computer Science and Engineering when he initially joined HKUST in 2002.

The state-of-the-art, purpose-built campus in Qingsheng, Nansha, is being developed as a complementary hub to HKUST in Hong Kong.

Degree programs will be cross-disciplinary and there will be no traditional division of fields into departments or schools. Instead, HKUST(GZ) will operate under four interconnected multidisciplinary hubs (function, information, systems, society) in a pioneering 21st-century academic structure, which Prof. Ni has helped to develop.

Prof. Lionel Ni, a renowned computer science and engineering scholar and highly experienced senior university administrator, will take the helm at HKUST's new Guangzhou campus (artist's impression), set to open in 2022.

Students need to be nurtured so that they develop the ability to identify and solve problems, Prof. Ni noted in an interview with *Times Higher Education*, a leading international university news and data provider, following his appointment in April 2021. "To do this, they would need to bridge diverse knowledge from multiple disciplines," he said.

The new campus is seeking to extend its reach to 4,000 postgraduates and 400 faculty within the first five years after opening; and undergraduates in the subsequent phase. Worldwide recruitment for accomplished faculty at all levels is on-going, with some 60 recruited by May 2021, including around 20 from the University's Clear Water Bay campus.

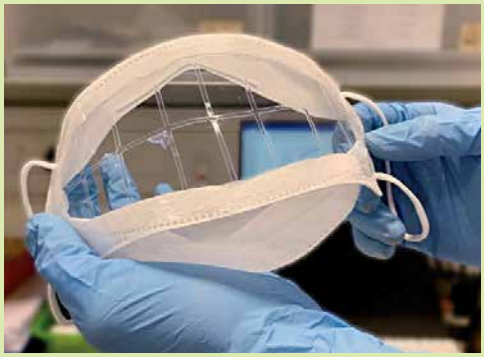
A HKUST(GZ) pilot scheme, whereby high-achieving research students can enroll and study at Clear Water Bay until the new campus is ready, will also begin its third cohort in 2021-22. More than 250 students have joined the first two cohorts.

Hi-tech talent on track for intelligent transportation

HKUST and Guangzhou Metro Group Co. Ltd. have signed their first cooperative agreement to nurture postgraduate talents in intelligent transportation, one of the key research thrust areas of the HKUST(GZ) campus. This innovative field, combining transportation, artificial intelligence, and data science, seeks to enhance the efficiency, safety, and sustainability of mobility systems for both people and goods. The MPhil and PhD degree programs will be available in 2021-22 under the HKUST(GZ) pilot scheme, with students jointly supervised by HKUST professors and professor-grade senior engineers, or equivalent, appointed by Guangzhou Metro.

Tackling COVID-19 on multiple fronts

In Focus 32 showcased a series of leading technologies developed by School of Engineering faculty to assist the fight against the coronavirus. Here, recent research and education initiatives are highlighted



Transparent masks

Prof. GAO Ping, Chemical and Biological Engineering, has produced a novel transparent polymer nanofilm prototype face mask that has achieved 99% filtration efficiency for virus, bacteria, and particulate matters in tests in line with N95 respirator standards. The nanofilm developed by Prof. Gao is made from ultra-high-molecular-weight polyethylene (UHMWPE), a light-weight material used in bullet-proof vests. The nanofilm measures just 20 nanometers, or less than one-thousandth of the thickness of a hair, yet is 25 times stronger in specific strength (i.e. takes density into account) than stainless steel with the same mass. It is also gas-permeable and waterproof.

Tracing environmental transmission

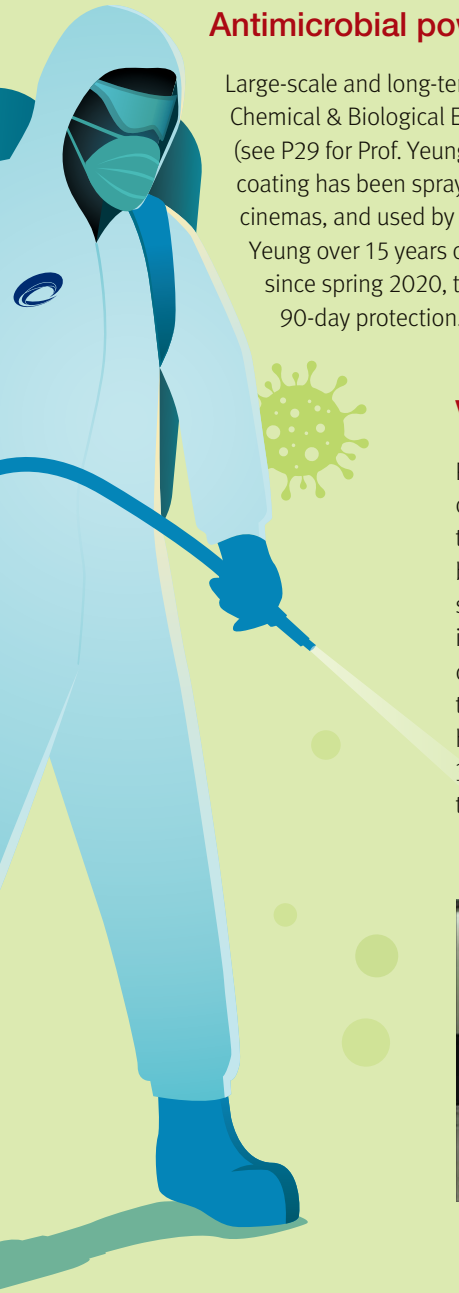
Prof. Gary CHAN, Computer Science and Engineering, and his research team have proposed and developed a patent-pending location-private approach using an internet-of-things wearable device to combat COVID-19's ability to spread by surviving on surfaces. The device continuously scans its user's environmental signal data, which are transmitted to the user's phone to be stored locally. If the user becomes a confirmed case, and upon his/her permission, the signal data are shared anonymously with other users for local matching so that those found to be a close contact would be alerted in private. The research team previously pioneered the geofencing technology for StayHomeSafe mobile app, a key part of Hong Kong's quarantine order enforcement (see P29 for Prof. Chan's commendation).

Easing quarantine blues

Nora is an emotionally intelligent virtual agent, designed by Prof. Pascale FUNG, Electronic and Computer Engineering, and her team to assist those finding it difficult to adjust to quarantine. Through regular private and confidential conversations and meditation/exercise, a user can keep up a beneficial routine for their mental health. In addition, Nora carries out temperature checks and breathing exercises via self-screening, and keeps track of these and other mood data, giving reassurance to the user over the isolation period. Using Nora only requires an internet connection and Chrome browser. Nora can currently converse in English, with more languages to be added later.

Novel light on disinfection

A research team led by Prof. Ricky LEE, Mechanical and Aerospace Engineering, has developed a closet that can kill 99.99% of bacteria and viruses on an item or garments inside within one minute, by enhancing the efficiency of the ultraviolet (UVC) light-emitting diode (LED) disinfection technique. UVC is frequently used for disinfection in public and private facilities but the light source in current products is usually mercury lamps, which have a lower germicidal effect, shorter lifespan and are bulkier than LED lights. The stacked silicon reflector, devised by Prof. Lee's team, offers a unique structure and optical design that has increased UVC output efficiency from 50% to 90%; and extended the sterilization distance by five times to 26cm while also achieving uniform radiation. The prototypes of this UVC LED disinfection closet have been installed at three sites of Po Leung Kuk schools for public trial.



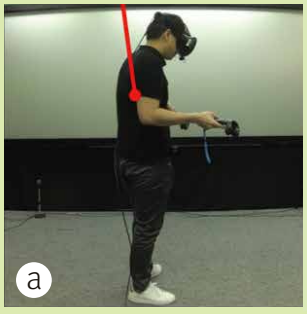
Antimicrobial powerhouse

Large-scale and long-term disinfection with the non-toxic smart antimicrobial sanitizer invented by Prof. YEUNG King-Lun, Chemical & Biological Engineering and Environment & Sustainability, continued to be widely applied in the community (see P29 for Prof. Yeung's commendation). Assisted by an industrial partnership with Chiaphua Industries Ltd., Germagic coating has been sprayed in schools, transportation vehicles, subdivided households, community centers for the elderly, cinemas, and used by government departments, among others, since March 2020. The coating, developed by Prof. Yeung over 15 years of research, can inactivate up to 99.9% of highly infectious viruses. Working with over 40 NGOs since spring 2020, the technology has benefited over 300,000 low-income residents in Hong Kong by providing 90-day protection.

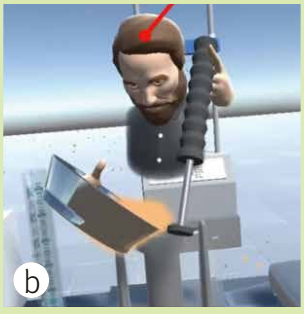
Virtual reality learning

Prof. Ben CHAN, Center for Engineering Education Innovation (E^2I), has steered the use of a number of cutting-edge teaching tools to assist educators and learners when in-person classes are difficult to hold or attend. One example is the development of a virtual reality recording system (see pictures below), using a motion capture system. This enables the instructor to record an experiment for students to carry out virtually, using goggles and controllers to follow the instructor's lead. Another innovation is a "mixed reality classroom" that provides the instructor with a 3D stereoscopic display. A positioning system then tracks the instructor's head movement to create the illusion that the teacher is immersed in the virtual environment. Since early 2020, civil engineering students have also been able to don goggles (or use Google's Cardboard virtual reality headset) to watch 360° field trips featuring an instructor on site, allowing viewers to feel that they are actually moving through the location along with the instructor.

Instructor in the real world

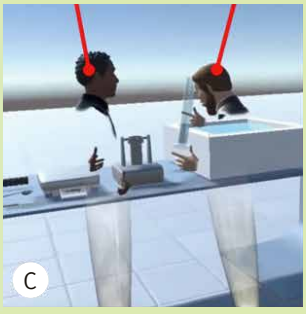


Instructor in VR



Student's point of view

Student in VR Instructor in VR

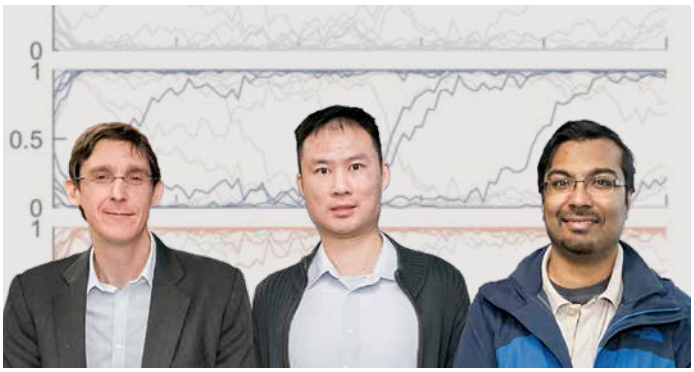


Instructor's point of view

Fresh insights into HIV mutations

An international research team co-led by a School of Engineering faculty member has developed a novel method to study how HIV mutates to escape the immune system.

The HIV virus, which can lead to AIDS, has proved particularly difficult for the human immune system to eradicate due to its ability to rapidly evolve. Genetic mutations enable the virus to escape the body's defence system of T-cells and antibodies, and make it especially challenging for lasting solutions to be designed. While there is currently no effective cure, HIV can be controlled with medication.



Prof. Matthew McKay (left) and research team members Dr. Muhammad Saqib Sohail (right), HKUST postdoctoral fellow, and Dr. Raymond Louie (center), University of New South Wales and formerly a research assistant professor at HKUST.

The new approach, published in an article in high-impact journal *Nature Biotechnology*, stems from a study led by Prof. Matthew MCKAY, Electronic & Computer Engineering and Chemical & Biological Engineering, and Prof. John BARTON, Physics & Astronomy, at the University of California, Riverside.

The team devised its "marginal path likelihood" method using conventional statistical physics to reveal patterns of selection in HIV evolution in 14 HIV-infected individuals, with findings indicating that the method could efficiently distinguish between mutations that help the virus evade the body's immune system and random variations.

"The accuracy and high efficiency of our approach enable the analysis of selection in complex evolutionary systems that were beyond the reach of existing methods," Prof. McKay said.

Given the general nature of the method, it could also be used to study diverse evolutionary processes, such as the evolution of drug resistance of pathogens and the evolution of cancers, he noted. However, the team had focused on HIV as a test system due to its extraordinary capability to mutate and escape the human immune system.

"The details of these immune escape dynamics are not well understood," he said. "If we can gain a clearer picture of how HIV evolves within a person, this may help to develop better treatments or vaccines against the virus."

Hi-res view of living brain

Imaging technology that sheds light on brain functions in regions that have never been well explored has been developed in a collaborative endeavor between Prof. QU Jianan, Electronic and Computer Engineering, and HKUST neuroscientist Prof. Nancy IP, Vice-President for Research and Development and The Morningside Professor of Life Science.

In developing their adaptive optics two-photon endomicroscopy system, the research team used a localized fluorescence signal as a "guide star" inside biological tissues, which allowed them to measure aberrations of the miniature endoscope being employed as well as the brain tissue. The development now makes in vivo (live) imaging of deep brain structures possible at a high resolution.

Prof. Qu, who specializes in biophotonics, optical devices and systems, and optical image processing research, said: "The ability to conduct live imaging of the deep brain at high resolution has long been a challenge. With adaptive optics two-photon endomicroscopy, we can now study the structures and functions of the deep brain at an unprecedented

Charging forward with Li–S batteries

A novel cathode design concept that substantially improves the performance of potential next-generation batteries has been developed by a research team led by Cheong Ying Chan Professor of Engineering and Environment Prof. ZHAO Tianshou, Chair Professor of Mechanical and Aerospace Engineering and Director of HKUST Energy Institute.

Lithium–sulfur (Li–S) batteries are seen as significant potential alternatives to the lithium-ion (Li-ion) batteries commonly used in smartphones, electric vehicles, and drones. They are known for their high energy density, holding out the possibility that the 400km range for driving a Li-ion battery-powered electric vehicle on a single charge could be extended to 600km-800km. In addition, their major component, sulfur, is eco-friendly, naturally abundant, light, and cost-effective.

However, Li–S batteries have faced several challenges in moving the technology to an industrial scale. These include progressive leakage of active material from cathode and lithium corrosion, resulting in a short battery life, and the need to reduce the amount of electrolyte in the battery while maintaining stable battery performance.

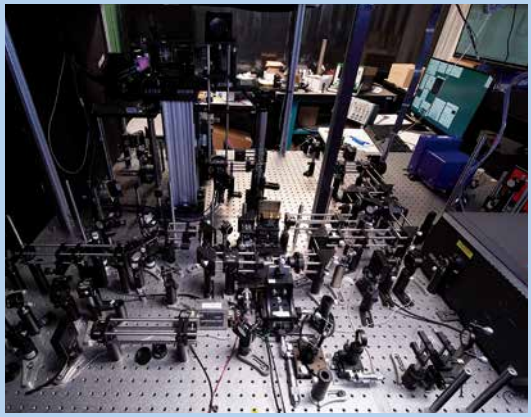
Prof. Zhao, who has made seminal contributions in the areas of fuel cells and advanced batteries, and his School of Engineering team collaborated with international researchers from Argonne National Laboratory and Stanford University in the US, Xiamen University in Mainland China, and Imam Abdulrahman Bin Faisal University in Saudi Arabia to address these problems. The research findings have been published in *Nature Nanotechnology*.

Prof. Zhao Tianshou and his research team: their novel cathode design enhances next-generation Li–S battery performance.

The researchers' innovative cathode design comprised nanoparticles and a single-atom catalyst to form double-end binding sites inside a highly oriented macroporous host. The host could then uniformly accommodate the sulfur while abundant active sites, embedded inside, tightly absorbed the polysulfide. This eliminated the polysulfide shuttle effect causing the leakage problem and lithium metal corrosion, and also increased the batteries' energy density.

resolution, which will greatly accelerate our progress in understanding the mechanisms of many neurodegenerative diseases and in developing related treatments."

Using the new technology, the researchers investigated neuronal plasticity in the hippocampus, a critical deep brain structure with a major role in memory and learning. As a result, they were able to reveal the relationship between somatic and dendritic activity of pyramidal neurons within the hippocampus. The findings have been published in *Science Advances*.



The adaptive optics two-photon endomicroscopy system developed by Prof. Nancy Ip and Prof. Qu Jianan (both pictured center).

First ‘Extended Major’ in Hong Kong

A novel engineering undergraduate degree with an “extended” academic framework but no extension of the time required to graduate has been launched at the School of Engineering (SENG).

Engineering + Artificial Intelligence (AI) is due to be rolled out in the 2021-22 academic year as one of two pioneering extended bachelor degree programs under HKUST’s new “Major + X” degree structure.

The initiative seeks to blend traditional programs with popular emerging areas, such as AI, offering better integration of existing and new knowledge to respond to the changing needs of society.

Engineering + AI will offer students from all SENG disciplines the opportunity to gain complementary cross-disciplinary understanding of AI in their major field. The AI extension will utilize problem-solving skills, insights through a design thinking course and professional seminars in AI, and a capstone project enabling students to explore AI applications relevant to their discipline. Overall, it will involve approximately one additional course per term.

The other extended degree program will be available to undergraduates in the School of Science.

Students will still finish their degree program in four years, with a degree in their traditional major and the extended subject. Future extended majors may cover areas such as digital media and arts, fintech, and data science.

The extended major format will enable HKUST engineering undergraduates to gain complementary cross-disciplinary understanding of AI in their major field within a regular four-year degree time frame.

Boost for innovation ‘dreamers’

A HK$20 million donation to HKUST is set to enhance development in innovation and technology (I&T), research, and education at the University, with HK$2 million used to set up a student scholarship recognizing academic excellence.

The donation by Mr. Andy FEI Chi-En will see the establishment of the Fei Chi En Education and Research Fund. The scholarship will be named after the Y-Lot Foundation, a charitable non-profit organization founded by Mr. Fei to help young people build positive attitudes and values through collaborations with different sectors of the community.

The Dream Team Open Lab, overseen by the School of Engineering, will also be renamed the Fei Chi En Dream Team Open Lab in appreciation of Mr. Fei’s support. The Lab offers a place to bring together students from different schools and disciplines to turn their creative ideas into projects and prototypes for competitions.

Mr. Fei said he hoped that the collaboration with HKUST would create a platform that provides more space for young people “to chase their dreams, develop more innovative products, and drive the development of the I&T industry in Hong Kong”.

HKUST President Prof. Wei SHYY said he was grateful to Mr. Fei for his generosity and trust in the University. “We share the same mission with Mr. Fei on nurturing talents with global vision and commitment to serve the society.”

A student explains the workings of a vehicle designed by the HKUST Electric Vehicle Racing Group to donor Mr. Andy Fei Chi-En in the newly named Fei Chi En Dream Team Open Lab.

Designs on trams of the future

Prof. Tsui Chi-Ying (third right), Dr. Luisa Mok (second left), Mr. Cyril Aubin and Mr. Nixon Cheung, Hong Kong Tramways (third and first left), with students Jasmine Li, Seabreeze team, and Katie Chong, Flow team (first and second right).

A far-sighted experiential learning project has seen undergraduates from the School of Engineering's Division of Integrative Systems and Design (ISD) collaborate with Hong Kong Tramways to devise innovative eco-friendly design concepts for a future fleet of the city's iconic trams.

The project was focused on extending the trams' low-carbon footprint, helping to develop students' critical and creative thinking in approaching complex social problems, particularly those related to the global challenges of climate change, and offering some intriguing ideas for Hong Kong Tramways.

Twenty-seven students participated in the Systems Thinking and Design course, led by Dr. Luisa MOK Sze-Man, Lecturer, ISD, in the 2020 Fall semester, resulting in a total of 10 diverse models that sought to enhance passenger flow and improve air ventilation in future vehicles.

Hong Kong's trams have been in operation since 1904, with those now rolling along the tracks mostly belonging to the sixth and seventh generations of design. Looking ahead to the eighth generation, students took creative approaches to solving the different operational challenges.

One team tackled the air ventilation issue through the use of a specially designed passive air tunnel system to improve upper deck ventilation, an open staircase connecting to the air tunnel to boost lower deck ventilation, and a wavy structured ceiling design for look'n'feel and passenger experience.

Other student concepts ranged from the use of evaporative cooling, among other effects, to solve the high-temperature issue to ergonomic tilted seats to help passengers' posture, and an improved staircase design to enhance safety and passenger flow.

Mr. Cyril AUBIN, Managing Director of Hong Kong Tramways, said he had been impressed by the students' concern for both the environment and the comfort of tram users. "Designing trams is not just about the transport, but also about connecting with people, our city and history," he pointed out. "The students were able to capture all that."

Prof. TSUI Chi-Ying, Head of ISD, further noted that the project had helped students to develop ideas in a useful, creative, and aesthetic way, which was "what we want to see".

ISD offers a distinctive student-centric curriculum and project-based learning approach, providing students with multidisciplinary training in integrative systems and design by studying and working in teams.

The Seabreeze team used evaporative cooling and the Coanda effect in its design.

The Flow team sought to improve upper deck ventilation and provided a wavy ceiling design to enhance the look'n'feel for passengers.

Choices, timing, and options

Prof. Kei May Lau, the first woman engineer to win the J. J. Thomson Medal for Electronics, discusses how a passion for seeing novel devices work and a determination to choose her own destiny have helped her succeed

As one of the few women working at the highest echelons of electronics and photonics technology, Prof. Kei May LAU, Chair Professor of Electronic and Computer Engineering, has been a pioneer in a host of ways during her high-flying 20 years at the School of Engineering.

In recognition of her groundbreaking basic research into compound semiconductor materials and device physics, Prof. Lau recently became the first female engineer to receive the Institution of Engineering and Technology's J. J. Thomson Medal for Electronics in the award's 45-year history.

A major area of such research has been related to light-emitting diode (LED) technology, to which she has been an on-going contributor since the 1990s. At that time, white LEDs appeared to offer a novel power-saving potential alternative to heat-emitting incandescent light bulbs and mercury-enabled fluorescent lights. Now, thanks to the continuous advances of Prof. Lau and other engineers taking development forward, LEDs are ubiquitously used for illumination in essentially all sectors, from household to commercial lamps, aviation lighting to horticultural grow lights.

Describing the attraction of a career in engineering, Prof. Lau said that unlike scientists whose role was to explore and attempt to explain natural phenomena, engineers seek to create practical applications that can benefit humanity, taking into consideration performance as well as cost in their designs. To sum up this view, she coined the term "ecotronics" to describe research on electronics for ecology and economy. "I love to see things work instead of solving equations or building models using simulations only," she said.

Among the early researchers on-board with LED technology, Prof. Lau started focusing on its miniaturization 16 years ago. She has developed high-resolution fingernail-sized LED micro-display chips that could be used to build three-in-one traffic lights or virtual windows, and micro-displays for augmented reality (AR) and virtual reality (VR), among other applications. Meanwhile, a near-to-eye micro-display she has developed can be incorporated into a pair of smart glasses with a connected camera to offer a rear view or to your mobile phone.

Electronics and photonics specialist Prof. Kei May Lau sees choosing a research subject as similar to predicting the future.

She has also used her expertise to investigate transistors and lasers.

"Choosing a research topic to focus on is a bit like predicting the future. Some predictions come through, many others don't," Prof. Lau said. "When conducting engineering research, we want to do something people care about and that will pan out. The most challenging part is coming up with visionary ideas. The timing of getting into a new topic is critical as well."

Where LEDs were concerned, she "bought into the idea as I thought it made sense", she said. "You can say my timing was good."

In addition, innovation and experience are intrinsic elements of technology breakthroughs, she noted. "I always tell

students that connectivity is the most important attribute. When students complain that what they learn is not useful, I would say that it is not that the material is useless, but that they have yet to figure out how to link up the newly acquired information with their experience and knowledge."

Born in Hong Kong and a graduate of Pui Ching Middle School, Prof. Lau went to the US for higher education, earning her BS and MS in physics from the University of Minnesota, Minneapolis, and a PhD in electrical engineering at Rice University in Houston, Texas. Given that electrical engineering is largely based on physics, with engineers adapting the laws of physics to originate useful new applications, she saw her move into the area as a natural fit for her interest.

Following her doctorate, Prof. Lau worked in the US in industry, then moved back to academia at the University of Massachusetts Amherst (UMass) in the 1980s. In 1993, she became the first woman to gain promotion to full professor in the university's College of Engineering. Her initial connection with HKUST was as a visiting professor in 1998. Two years later, she left UMass to join the School of Engineering at HKUST.

According to Prof. Lau, a major reason that fewer women enroll in engineering programs is that multi-talented girls often have many options to choose from, be it in the arts, business, or medicine. Or they might get "pushed" into areas seen as more lucrative by their family, she said.

To young females undecided about a future direction, she suggests engineering can provide rigorous training in problem solving as well as analytical skills, which will be highly useful no matter what direction they eventually embark on. It is much easier changing from engineering or science to business or liberal arts than the other way around.

In her own case, despite the numerical male-female imbalance in the engineering field overall, Prof. Lau said she has never let gender limit her career choice, which has seen her combine leading-edge research with teaching and raising a family.

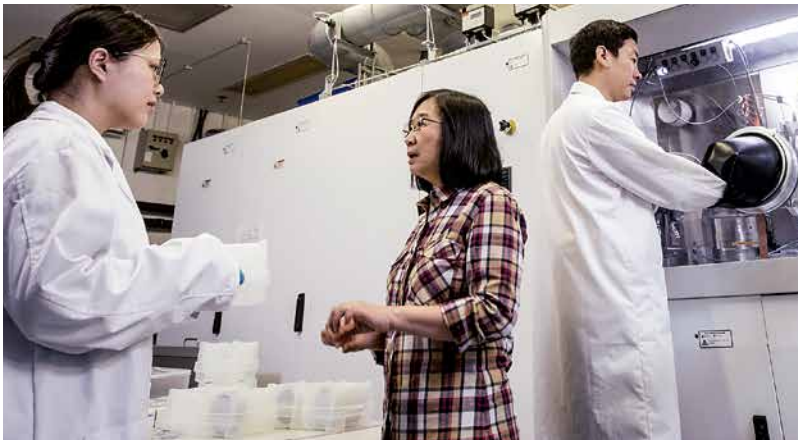
"Perhaps my personality of not caring too much about others' opinion on what I should or should not do helps," she said. "For young women who aspire to be successful professionals, deciding on their own destiny matters the most."

This approach has certainly seen her succeed in her career. Along with the recent J. J. Thomson Medal, she is a recipient of the Optical Society (OSA)'s Nick Holonyak Jr. Award, IEEE Photonics Society Aron Kressel Award, and US National Science Foundation (NSF) Faculty Award for Women Scientists and Engineers. She is also a Fellow of IEEE, OSA, and the Hong Kong Academy of Engineering Sciences.

Such recognition from her peers is highly encouraging for all the researchers in her group, she said. But there are still many research problems yet to be explored. Her current focus is the integration of electronics and photonics, with her research group recently achieving a breakthrough by developing the world's first bufferless telecommunication wavelength (1.5 micro-meter) III-V semiconductor lasers grown directly on industry-standard 220-nanometer silicon-on-insulator (SOI) wafers.

The innovation brings the prospect of major improvements to the infrastructure of high-speed network communications in data centers a step closer. This in turn could potentially lead to faster, cheaper services as well as novel applications.

"A vast amount of data needs to be transmitted and processed swiftly and efficiently at any instance," she said. "The smaller the electronic circuits are, the quicker the signal passes. Transistors can now be fabricated as small as a few nanometers. Light (photons) in integrated circuits could help speed up data transmission much further. How to enhance the performance of semiconductor photonic integrated circuits? This is what we are now researching, and it is a never-ending task."



Prof. Lau with her students in the lab: "I love to see things work rather than solving equations."

Bioinformatics scientist joins battle to treat brain cancer

Leading early career computational biologist Prof. Wang Jiguang and his genomics research laboratory are helping to set the pace in understanding an especially aggressive and hard-to-beat disease

Applied mathematics may not initially appear a likely source of solutions for cancer treatments. But as boundaries of traditional academic disciplines shift in the era of big data and rapid technological advances, novel research horizons are opening up, offering exciting new avenues to mix and match previously separate fields and uncover fresh insights and potential therapeutic pathways.

Computational biologist Prof. WANG Jiguang (Chemical & Biological Engineering and Division of Life Science) is among the dynamic young minds adding an extra dimension to medical research through bioinformatics and mathematics, while also delivering hope to patients suffering from one of the deadliest types of brain cancer: glioblastoma.

Prof. Wang and his interdisciplinary Wang Genomics Lab are exploring how to assist the design of treatments through cancer genomics, helped by their breakthrough in identifying the mutation mechanism leading from lower grade glioma to secondary glioblastoma (sGBM) through a specially designed computational model.

Glioblastoma, the rare brain cancer that Prof. Wang is tackling, has seen few successful treatments in the past 15 years. The disease, affecting three to four people among 100,000 per year, is invariably fatal as even after treatment most malign tumors mutate and return again, with patients on average only surviving for 15 to 16 months from diagnosis. Prof. Wang's discovery indicated METex14 mutations at the MET oncogene as a major factor behind aggressive progression from lower grade glioma to sGBM.

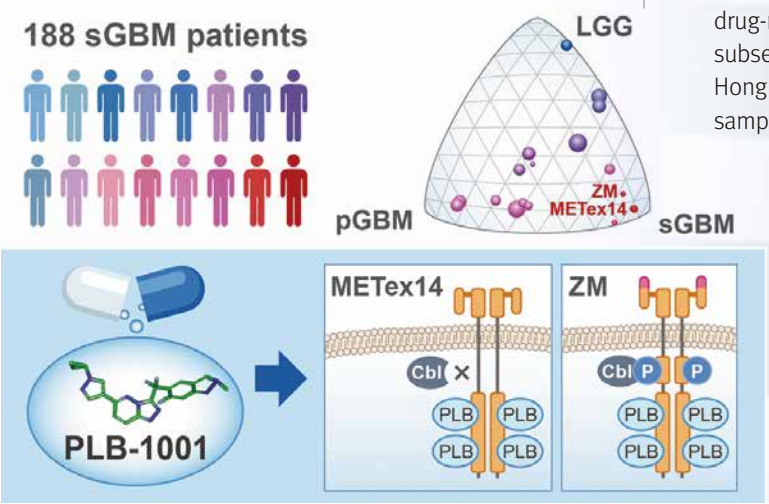
The finding, published in leading journal *Cell* in 2018, was the result of a collaboration with Beijing Tiantan Hospital scientists. It led on to the identification of a drug molecule (PLB-1001) as a possible treatment by the Beijing team and a clinical trial that saw tumor shrinkage in two of 18 late-stage cancer patients, furthering knowledge of how to treat sGBM.

"Developing computational models on cancer evolution helps predict cancer cells' future behavior and prioritize treatment options, while precision cancer medicine promises to tailor treatments according to personal cancer mutations," Prof. Wang noted at the time.

In a more recent advance, with findings published in *Nature Communications* in 2020, an international team co-led by HKUST, Beijing Neurosurgical Institute, and the Spanish National Cancer Research Center used computational analyses carried out by the Wang Genomics Lab to discover a mechanism to explain why a subgroup of glioma patients develops chemo-resistance to the current treatment for glioma. Such treatment usually comprises a combination of surgery, radiotherapy, and the chemotherapy agent temozolomide (TMZ).

The discovery can potentially allow early identification of drug-resistant brain cancer patients, with Prof. Wang subsequently collaborating with the Chinese University of Hong Kong and Prince of Wales Hospital to expand samples to local patients.

Prof. Wang's drive to contribute to this area has been spurred on by his visits to hospitals, where he has seen the human cost – to people of all ages, including young children



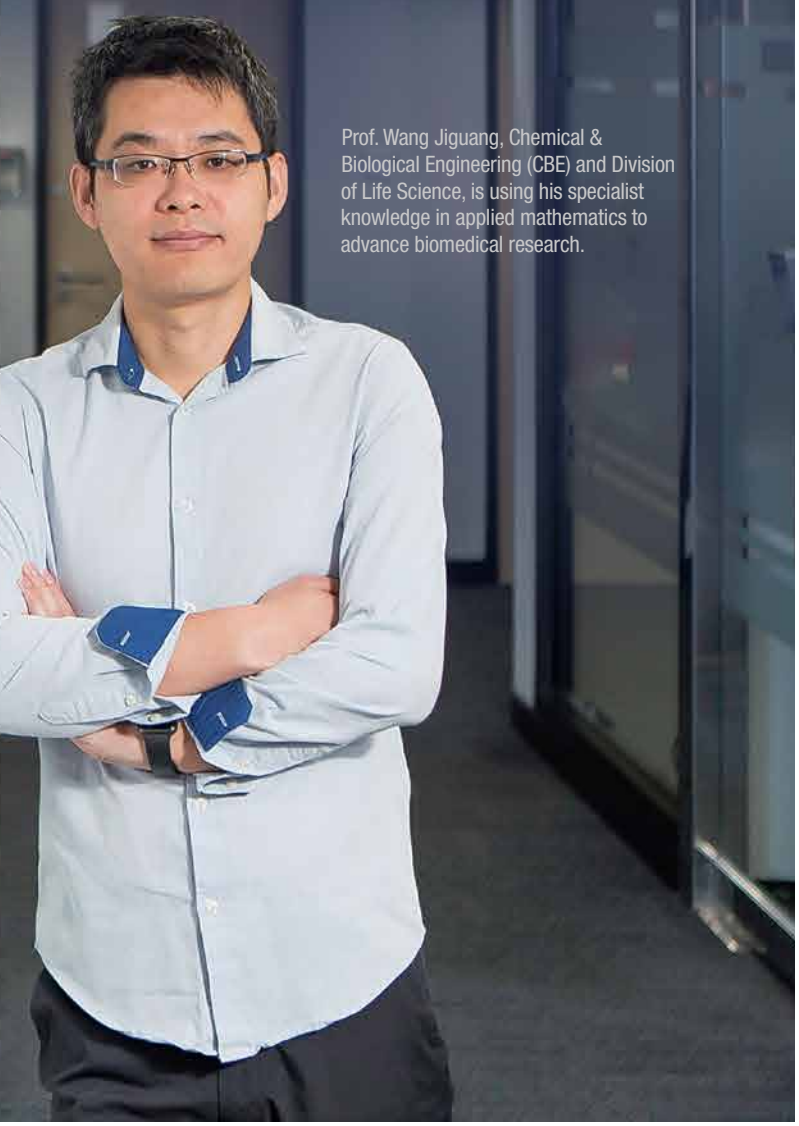
Prof. Wang's discovery indicated METex14 mutations at the MET oncogene as a major factor behind aggressive progression from lower grade glioma (LGG) to secondary glioblastoma (sGBM).

– of those suffering from the condition, and patients, parents, and other relatives in desperate need of hope. “As a parent of two kids, I do not want to see this desperation in others,” he explained.

Born in Hebei province in Mainland China, Prof. Wang was raised in a family of teachers. His liberal-minded parents gave him encouragement to play rather than pressure. Motivation then came from within, with the youngster developing a fascination for mathematics and physics, as well as the medical field.

“As a child, I wondered why people got sick and how they got healed,” he said. “I had the dream of becoming a scientist when I grew up.”

He was soon on his way, winning a host of national mathematics contests. He joined Beijing Institute of Technology without having to take the National College Entrance Examination after obtaining First Class standing in the Chinese Mathematical Olympiad when he was in his final year at high school.



Prof. Wang Jiguang, Chemical & Biological Engineering (CBE) and Division of Life Science, is using his specialist knowledge in applied mathematics to advance biomedical research.

The rising academic star continued to stand out at university, where he studied information and computational science. Following this, he was accepted for a postgraduate program at the Academy of Mathematics and Systems Science of the Chinese Academy of Sciences, again without having to sit the usual entrance examination because of his top academic results. There, he undertook applied mathematics focusing on operations research and cybernetics, receiving his doctorate in 2011.

Postdoctoral research at Columbia University in the US came next, where he went on to be named an Irving Institute Precision Medicine Fellow. Specializing in computational biology and bioinformatics, he integrated data of cancer patients from different hospitals to learn about cancer mutations and helped biologists and clinicians solve biomedical problems by analyzing enormous amount of data using statistics and machine learning. He joined HKUST in 2016.

“All sciences, at higher levels, become mathematics,” he said. “They become data with the need for data analysis, and thus we have to think quantitatively.”

As an indication of the significance of his work on others in the field, Prof. Wang, who is still only in his mid-thirties, has published more than 20 papers with an impact factor higher than 10.

He was among the first batch of scholars in Hong Kong and Macau to be named a National Natural Science Foundation of China (NSFC) Excellent Young Scientist when the award scheme was opened to applicants from the two Special Administrative Regions in 2019. It is among China’s most prestigious awards for young scientists under 38.

Further recognition earlier this year saw Prof. Wang chosen to receive the Zhong Nanshan Youth Science and Technology Innovation Award – the only awardee from Hong Kong.

At HKUST, his sterling work was heralded with the School of Engineering Young Investigator Research Award 2018-19. He is also keen to share his knowledge directly, supervising over 10 postgraduate students and several postdocs to date.

One of his key insights for these young researchers is the importance of asking questions and to find the ones that they are particularly keen to resolve. “Everyone has a different question in life,” he explained. “Find the right field and right route… and do not think too much about status and all that.”

Meanwhile, persistence and the courage to take an individual career path are also indispensable. “Be yourself, and never give up,” Prof. Wang said.

Building the AI 'brain' behind smart Hong Kong

Prof. Chen Kai and his research team are driving forward the development of a comprehensive smart urban environment through their advanced high-performance AI computing cloud platform

Smart bus schedules, taxi dispatching, typhoon warnings, medical diagnoses, and fintech are all set to be part of everyday life in Hong Kong soon, thanks to the development of a next-generation artificial intelligence (AI) computing cloud platform that will drive and deliver Hong Kong's smart city applications.

One of the key people helping to implement this dynamic integrated "IT brain" is Prof. CHEN Kai, Computer Science and Engineering. He is working together with Hong Kong government departments to set up the technology infrastructure to realize the vision of smart mobility, living, environment, people, government, and economy encompassed in the government's Smart City Blueprint, announced in 2017.

The high-performance hub will also enable researchers and practitioners to participate in data collaboration through inter-city knowledge sharing.

Prof. Chen, who is still only 40 and identifies with the "smart"-technology generation – was far from a city boy when he was younger, originally hailing from a village of just seven families in landlocked Anhui province in eastern China.

There, he had to walk 10 kilometers to attend school in a nearby town, only venturing to a major city – Shanghai – for the first time as a teenager. That one visit, though, was enough to show him another world besides mountains, and make him realize that he wanted to be part of it. "I learned that the world was colorful and it inspired me to go out and explore when I grew up," he said.

Now Prof. Chen is using that curiosity about the wider world to take urban life to the next level. In July 2020, he became the youngest academic yet to receive prestigious Research Grants Council (RGC) Theme-based Research Scheme funding when a budget of HK$33 million was approved for the smart city infrastructure IT platform.

He is serving as project coordinator in the collaborative project with other universities to generate a high-performance distributed machine learning framework.

The framework seeks to efficiently handle and make accurate predictions from graph-based streaming data to support smart city applications for key areas such as transportation optimization, urban planning, and crowd sensing. To do this, it will need to overcome the current challenges including data scarcity, algorithm limitations, and computing power inefficiency.

One proposed solution to the first two issues is to devise inter-city transfer learning algorithms, which will enable knowledge learned from other cities with rich data sources to be added to the Hong Kong model and vice versa. Meanwhile, high-performance distributed AI computing architecture to support such deep learning and transfer learning for large graph streaming data, including the adoption of remote direct memory access (RDMA), aims to achieve high-throughput, low-latency communications to improve cluster computing efficiency.

Prof. Chen and his intelligent System Networking (iSING) laboratory researchers at the School of Engineering (SENG) are also seeking to address privacy concerns related to transfer and sharing of data.

"Firstly, there is high performance so we can handle big data within short time frames, often reducing work duration from weeks to days or even hours for large AI model training," Prof. Chen said. "Secondly, there is privacy preservation as we use encryption to enable technologies that can learn from data and do so without disclosing identities in relation to the data."

In the case of medical data, for example, individual hospitals need to protect information related to their own patients. However, the medical community as a whole needs to combine data from different hospitals to enlarge sample sizes for research. To address hospitals' concerns, Prof. Chen and his team will deploy advanced encryption technologies so that data can be combined to establish models for collective learning and disease diagnoses. Most importantly, the actual data will never leave individual hospitals, which he sees as a great step forward in privacy preservation. The same principle can be applied to financial services across banks.

Currently, though, he and his team are working with the Transport Department and Hong Kong Observatory with the aim of optimizing Hong Kong's transportation system. His team has collected massive spatial-temporal graph-based city data, which can be leveraged by deep neural networks, such as graph convolutional networks to build powerful models for different smart applications.

High-performance career

In addition to his own research lab, Prof. Chen Kai is advancing the networking and high-performance AI computing field as:

- Director, WeChat-HKUST Joint Lab on Artificial Intelligence Technology (WHAT Lab)
- Executive Vice-President, Hong Kong Society of Artificial Intelligence & Robotics
- Chair of the Steering Committee, Asia-Pacific Workshop on Networking
- Editor, *IEEE/ACM Transactions on Networking*
- Co-founder of Clustar, together with departmental colleague Prof. YANG Qiang. The company is focused on big data and AI solutions, and has received funding support from Sequoia Capital.

Prof. Chen Kai and his plans for Hong Kong's AI computing cloud platform. He has already seen system designs adopted by Google, Huawei, and Nvidia.

The research is seeking to reduce waiting time and traffic jams through smart bus scheduling, flexible rearrangement of traffic lanes during rush hour as well as predictions of passenger hot spots for taxi dispatch.

Prof. Chen, with his intelligent System Networking (iSING) lab team, who are helping to devise the technology infrastructure behind Hong Kong's smart city applications.

Prof. Chen's own journey to Hong Kong and HKUST was one driven by hard work and excellence. He was one of only two students in his junior middle school to gain entrance to a prestigious provincial senior high school, and from there he went on to take a bachelor's and master's degree in computer science at the University of Science and Technology of China in Hefei, the capital of Anhui.

In 2007, he started doctoral studies in computer science at Northwestern University in Chicago, US, and a year later read one of the first papers focused on data centers and cloud computing. He immediately recognized the emerging field's huge significance and decided to make it his main research focus. In 2009, he undertook a three-month internship at Beijing's Microsoft Research Lab, inspiring him to write a paper on data centers when he returned to the US.

After working non-stop on the article for months, even during holidays, he was accorded the satisfaction of seeing it accepted as a Best Paper candidate at ACM SIGCOMM 2010, the most prestigious conference in the field – and renowned for its low acceptance rate for papers. In 2012, he was awarded a PhD from Northwestern University, joining HKUST the same year.

At SENG, Prof. Chen has continued to thrive, initiating his own lab and pursuing cutting-edge research in relation to data centers and cloud computing. This has seen him keep up his pioneering contributions to ACM SIGCOMM, with two papers accepted to the 2016 conference – the first such papers generated from Hong Kong.

Among the challenges he faces – and a major difference with theoretical research – is the need to devote enormous amounts of time to building a real system involving numerous computers. "It could take two to three years to build one system for one paper," he explained. However, the knowledge gained from such system building has been put to good use. Together with students in his laboratory, he has engaged in research on hardware, software design, theories, and implementation and been rewarded by seeing their designs adopted by companies including Google, Huawei, and Nvidia.

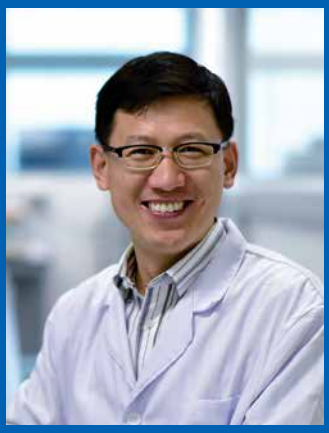
Such work has also laid invaluable groundwork for his current RGC research and smart-city AI computing hub for Hong Kong. He now anticipates that the platform will be open to HKUST faculty later this year and to all local universities by 2022. In the years ahead, he looks forward to even greater impact. "It will ultimately be adopted by the whole city," he said.

Sharing AI insights with top global minds

In November 2020, Prof. Chen Kai was invited to give a keynote speech at the Young Scientists session on artificial intelligence at the eminent 3rd World Laureates Forum in Shanghai. The annual forum, organized by the World Laureates Association, brings together top global scientific minds, drawing over 60 Nobel laureates in 2020. A series of Young Scientists Forums, held alongside, enable exchange among rising talents worldwide.

Also participating in the three-day Young Scientists gathering was fellow School of Engineering faculty member Prof. Matthew MCKAY, Electronic & Computer Engineering and Chemical & Biological Engineering, who has made significant contributions to computational immunology and spoke at a separate session on public health and the economy on learning from the COVID-19 pandemic, and two academics from HKUST's School of Science. Over 100 Young Scientists in total took part.

st century engineers



Prof. Marshal LIU is Associate Professor of Engineering Education in the Department of Chemical and Biological Engineering, and more recently Associate Director of the Center for Engineering Education Innovation. He received the HKUST Common Core Teaching Excellence Award 2019 and School of Engineering Distinguished Teaching Award 2014-15.

Learning to relish learning for its own sake

By Prof. Marshal Liu

As a common core educator, among other faculty roles, it is my responsibility – and joy – to encourage students at the start of their university journey to view learning as more than a means to an end.

I believe experiential learning has a great role to play. Such "learning by doing" through hands-on projects and practical experience forges an invaluable connection between knowledge and real life. It moves the gaining of knowledge away from a textbook perspective and test of memory to one connected to impact on students' own lives and those of others.

In doing so, it brings new purpose to a university education for students, becoming a treasured experience for self-development and future social contribution and not simply a route to a qualification and a personal step-up to career opportunities.

Technological change is happening at breakneck speed nowadays and engineering solutions are a critical factor in tackling many of the world's pressing challenges, including renewable energy resources, climate change, and global health. Thus, engineering educators have an important part to play in fathoming how best to deliver the student experience to inspire the next generation of professional engineers and technologists to look at issues widely and from different perspectives.

" 'Learning by doing' forges an invaluable connection between knowledge and real life"

In this regard, experiential learning, which has been an increasingly significant pedagogy at the School of Engineering in recent years, has certainly generated enthusiasm among students majoring in the School's different disciplines. Meanwhile, engineering concepts and know-how can also fruitfully be shared with non-engineering students, helping them appreciate how engineering affects people's lives and broadening their outlook on projects and issues in their own fields.

My own experience in designing and delivering the experiential "Introduction to Food Science and Technology" common core course since 2017 has demonstrated this. In connecting theories on food science with food processing technology and safety issues, feedback and the popularity of the course show that both future engineers as well as those outside the discipline value the new insights gained from conducting experiments and reflecting on the science that lies behind such endeavors.

Junior students recognize the need for logical and critical thinking, not rote learning. Discussions and debates that arise from such explorations – in this case, healthy diets and the aspiration for accurate information about what they eat – also encourage them to think more deeply about knowledge and its impacts on people's daily lives.

Learning to relish learning for its own sake is a powerful resource that will never leave students. It can enable them to achieve many more goals in their career – especially in a future that will be driven by lifelong learning – as they will be self-motivated to find out more. It can nurture personal development through a continuous expansion of understanding. Experiential learning is a key way to achieve this.

Hydrodynamic lift-off

James SHIHUA Mingzhi, Mechanical and Aerospace Engineering, has yet to complete his bachelor's degree. But the fourth-year student is firmly set on continuing his early research experience in aircraft engineering, gained through HKUST's signature Undergraduate Research Opportunities Program (UROP).

Outstanding early researcher James Shihua, Year 4, Mechanical and Aerospace Engineering, at General Electric China Science Park in Shanghai. His dream is to make airplanes more efficient and comfortable.

Up to the end of May 2021 and ahead of graduation, the would-be aviation engineering specialist has been furthering his knowledge at Shanghai Jiao Tong University State Key Laboratory of Ocean Engineering, where he is responsible for a research project involving the preliminary design and testing of an unmanned amphibious aircraft prototype. This September, he will begin his studies as a Hong Kong PhD Fellowship Scheme student at HKUST.

However, it was his second-year involvement in research into amphibious aircraft, in a project supervised by departmental faculty member Prof. Rhea LIEM, that first turned his attention to the exciting possibilities of aircraft that need to land and take off on water.

UROP enables undergraduates to work with faculty on research projects to gain experience of lab work and the team culture that a research career involves. In James' case, among other activities, he was able to spend a month carrying out towing tests on water tanks in the lab at Shanghai Jiao Tong University during the summer of his second year.

Following a semester's exchange at the University of Michigan in the US in fall 2019, James picked up his amphibious aircraft research at the School of Engineering. Working together with Mechanical and Aerospace Engineering MPhil student Arjit SETH, who was familiar with computational fluid dynamics simulations, and overseen by Prof. Liem and Prof. LI Ye from Shanghai Jiao Tong University, James' experimental data was teamed with Arjit's simulations to develop a standardized analysis procedure to evaluate the take-off performance of amphibious aircraft.

The Shanghai Jiao Tong University towing tank where James has conducted numerous tests as part of his research on amphibious aircraft.

The findings were published at the American Institute of Aeronautics and Astronautics (AIAA) Aviation 2020 Forum last June.

The same month, James, one of two recipients of a 2019 Hong Kong Institution of Engineers (HKIE) Aviation Scholarship for Outstanding Engineering Students, went on to beat nine other finalists to receive HKUST's 2020 Mr. Armin and Mrs. Lillian Kitchell Undergraduate Research Award for his project on "Designing Novel Efficient and Quiet Amphibious Aircraft for General Aviation".

It has been his dream since childhood to "make airplanes more efficient and comfortable so everybody can afford a pleasant air journey in the future", James said. Through UROP, which he sees as "one of the best ways for an undergraduate to acquire knowledge", it now appears he is well on his way to making that aspiration a reality.

Monitoring marine microplastics

A prototype for quantifying microplastics on the surface of seawater in real-time has become an award-winner for a cross-disciplinary final-year undergraduate engineering team.

The Smart Fish craft, devised for the 2020 graduates' Final Year Project, provides immediate and cost-effective monitoring and detection of the tiny plastic fragments (i.e. a diameter of less than 5mm) that are now ubiquitous in the environment due to increasing quantities of plastic litter. Conventional approaches are costly, time-consuming, and labor-intensive, limiting knowledge-gathering in the field.

Smart Fish at work, analyzing microplastics on the sea surface.

The craft takes its shape from a devil fish, with the streamlined design helping to reduce water resistance. The four-person team also developed a practical staining methodology to differentiate microplastics from other waste in a seawater sample as well as an image-capturing system that transfers real-time data to users via an interactive mobile app.

Students CHEUNG King-Pok, HO Man-Yat, WONG Pui-Him, Chemical and Biological Engineering (CBE), School of Engineering (SENG), and CHOW Chun-Sing, Ocean Science (OCES), School of Science, later saw their enterprising device recognized in the wider community when they won the Hong Kong Institution of Engineers (HKIE) Environmental Division Prize for Best Final Year Environmental Project 2019-2020. They were supervised by Prof. Frank LAM, CBE, and Prof. Cindy LAM, OCES.

This was the third year in a row that a project team involving SENG students received the championship.

Making a difference by helping others

The HKUST Wu Zhi Qiao Team, which seeks to improve the lives of villagers in remote areas of Mainland China by initiating and constructing footbridges, is preparing to make a welcome return to action after a pause in 2020 due to the COVID-19 pandemic.

The undergraduate team forms part of the Wu Zhi Qiao (Bridge to China) Charitable Foundation initiative. Its 2021 project will be located in Gansu, where villagers are already looking forward to a bridge to ease their commute across the river.

Students are currently carrying out preparatory work, with implementation subject to the COVID-19 situation.

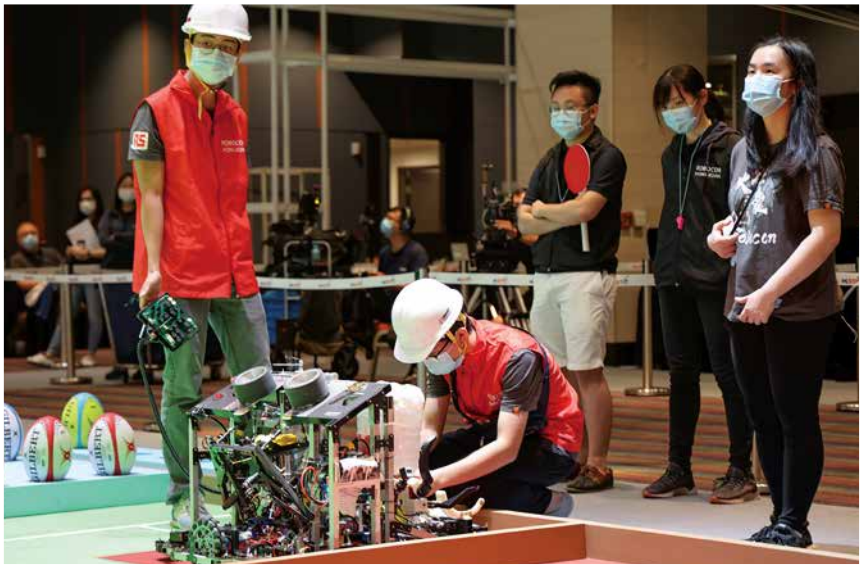
The team comprises cross-School student leadership, other undergraduate volunteers, and is advised by Prof. ZHANG Limin and Prof. Ben CHAN, both Civil and Environmental Engineering.

Members' commitment and dedication were recognized when the HKUST team received a Gold Award for Volunteer Service (Group) from the Hong Kong government's Social Welfare Department in 2019 for over 1,000 hours of community service.

Student volunteers help to position their newly constructed footbridge in Zhongting Village in Guangxi.

That year the team participated in a project in Zhongting Village in Guangxi, in partnership with Chongqing Jiaotong University and Zhejiang University. Students built a pedestrian truss footbridge across the nearby river, an incinerator to assist with much-needed waste disposal, and undertook other repairs.

Robotics Team races on



A HKUST rugby robot in action (left photo), and encouragement by War Dragon team leader Yiu Cheuk-Tung (right photo, first right) as teammates prepare to compete.

2020 proved one of the HKUST Robotics Team's stiffest challenges yet, as the COVID-19 pandemic and social distancing requirements added major complications to the teamwork involved in building the model machines that compete in local and international robotics competitions.

However, the high-performance team came through with aplomb, being named First Runner-Up and receiving the Best Presentation Award and a Special Award for their robot's agility in the Asia-Pacific Broadcasting Union (ABU) Robocon Festival 2020.

The competition was organized online for the first time in December 2020. Over 20 teams from more than 10 countries and regions in Asia-Pacific took part.

The HKUST Robotics Team is open to all students with an interest in robotics, with those from engineering disciplines forming a core part. First launched in 2004, it has become a popular and successful co-curricular activity, with members winning over 100 awards in leading student robotics contests in Hong Kong, nationally, and globally. Members also participate in community-based projects.

The two sub-teams formed to take part in the in-person Robocon 2020 Hong Kong Contest in September 2020 also performed remarkably. The War Dragon team was crowned champion – HKUST's 10th championship since 2004 – and the Fiery Dragon team won the Best Engineering and Best Artistic Design awards. A total of 29 HKUST students took part in the two teams, including nine non-local students from seven different locations in Asia.

The competition's theme in 2020 was "ROBO Rugby 7s", with participants required to build two robots to collaborate in picking up, passing, receiving, and kicking the rugby ball to successfully score goals.

Coping with the ever-changing situation created by the pandemic required adaptability and persistence as the situation unfolded. Difficulties included teammates being stuck overseas, leaving only half of the Fiery Dragon team in Hong Kong to carry out the initial design and build stage. Meanwhile, the all-local War Dragon team had to discuss via regular Zoom meetings, finish tasks at home as much as possible, and stagger lab time so fewer people were present at one time.

However, the two sub-teams remained unfazed, dealing with every eventuality, including last-minute technical hitches with their robots requiring instant modifications.

"It was an incredible time to be part of the 2020 team. Not only did we learn how to build high-performing robots but all the uncertainties also taught us how to handle the unexpected and work together to overcome difficulties as they arose. An amazing experience!" War Dragon team leader YIU Cheuk-Tung, Year 3 Computer Engineering, said.

Find out more about the team's story

Turning leftover bread into beer

Unsold bread is now being turned into beer in an enterprising food upcycling start-up launched by a School of Engineering undergraduate and her HKUST teammates.

Third-year student Anushka PUROHIT, Electronic and Computer Engineering, had noticed long ago how the city's bakeries and coffee shops were often left with bread items that had to be thrown away at closing time.

Cheers! Undergraduate Anushka Purohit, Electronic and Computer Engineering, is one of the founders of Breer, an upcycling start-up that creates craft beer from unsold food.

After joining the School of Engineering and learning about the University's Entrepreneurship Center, the Indian-born, Hong Kong-raised young engineer realized she could at last try to remedy the situation.

Enthused by the prospect of contributing to greater sustainability through repurposing a currently wasted product, she teamed up with HKUST School of Business students Deevansh GUPTA, Suyash MOHAN, and Naman TEKRIWAL to pool ideas, marketing and management skills.

On further investigation, the group found that bread shared common ingredients with beer, including malted barley, hops, and yeast. With 78% of an average beer being made from barley, they also realized that bread waste could serve as an alternative source for this ingredient, with the added benefit of reducing production costs.

Convinced that the idea could work, the students went ahead to establish Breer, a sustainable craft beer brand. By May 2020, operational arrangements were underway for their first products – a lager and pale ale – thanks to active support in numerous areas from the Entrepreneurship Center and the help of "Breer-runner" volunteers to collect leftover bread from bakeries and restaurants.

Anushka also created a Breer App to provide real-time updates on bread waste collection and helper resources.

In October 2020, the first batch of 500-liter beers began to be sold to local bars and retail outlets. Gaining media attention for the successful enterprise, the team started to anticipate scaling up and seeking support from the venture capitalist community.

Instead, Entrepreneurship Center Acting Director Donny SIU advised the students to stay focused on enhancing their business and avoid bringing in a new stakeholder at too early a stage in their business learning journey.

Realizing the wisdom behind this suggestion, team members returned their attention to their products. "We felt we should focus on perfecting the brew and that's how we got back on the right track," Anushka said.

To fine-tune the flavors, the team worked with professional brewers to test different recipes. Customer surveys were also conducted.

Now Breer is concentrating on sales and promotion, with the company adopting a flexible sales strategy by selling through pop-up stalls as the food and beverage industry as a whole seeks to recover from the fall-out from COVID-19 pandemic restrictions.

Indeed, the most challenging part to date has not been drafting business proposals or manufacturing the beer but talking to local retailers about their products, according to Anushka. This has led to a personal breakthrough as well. "I can speak Cantonese but I was just too shy," she said. "But to sell our beers, I needed to step out of my comfort zone and talk retailers into cooperation." This led on to an interesting discovery. "Once I'm confident, I speak like a local!"

Breer lager and pale ale.

From design project to product ...

There was an exciting finale to the degree studies of three Class of 2020 Chemical and Biological Engineering undergraduates, after the long-lasting antimicrobial hand cream they developed as part of their final-year coursework went on to be successfully commercialized by an alumna-entrepreneur.

With health being a primary concern in the spring of 2020 due to the COVID-19 pandemic, Andy CHOY Man-Hin, Isaac KWAN Chi-Shing, and Michael LUI Wing-Piu came up with the idea of creating an antimicrobial hand sanitizer for their Product and Process Design course, bringing together the theories and skills learned over their four-year bachelor's degree to design a viable real-world product.

Given the significant focus on hand hygiene to combat the spread of the coronavirus, they decided to focus on developing a lotion that not only killed microbes and maintained the aseptic environment on hands for hours, but protected skin from the moisture loss and allergic reactions that alcohol-based gels may cause.

Under the guidance of departmental faculty member Prof. Marshal LIU and despite the additional challenges of COVID-19 restrictions, the trio collaborated online and in-person when possible on the conceptual design. They investigated and selected the active ingredients which could work synergistically to kill microbes and the virus, and came up with the formulation to provide the ideal hydrophilic-lipophilic balance value for the gel to stay on the skin.

To ensure the design was practical for industrialization, they also explored the manufacturing process, drew up a business plan, and undertook economic analysis.

The excellence of the work carried out for the experiential (learning by doing) project saw the students pass the course with flying colors. However, now their interest had been fired, the team members were super-keen to take the project further by making a prototype to test the product's safety and effectiveness. Would anyone be interested in investing in a student-initiated idea?

This is where alumna Vanessa HO Po-Ki stepped up. Alerted to the project by Prof. Liu, and intrigued by the hand cream's potential, Vanessa and the students started discussions. "It was an unexpected and invaluable chance for us," Andy said.

Once the possibility of a prototype emerged, product safety was the next issue. The prototype had to be adjusted to meet different countries' regulations and laws, and the duration of the antimicrobial effect tested.

After ascertaining that most labs in Hong Kong could not help with such effectiveness trials, the students undertook the experiments themselves, with the support of the University's own Chemical and Biological Engineering labs and equipment.

cont. P26 ►

From left: then final-year students Andy Choy, Isaac Kwan, and Michael Lui, Chemical and Biological Engineering, who have developed a long-lasting antimicrobial hand cream that is now being sold.

... thanks to alumna's helping hand

Vanessa HO Po-Ki (1998 BEng in Chemical Engineering) was happy to assist the three Chemical and Biological Engineering final-year undergraduates to produce their antimicrobial hand cream, having had first-hand experience of the challenges in starting out as an entrepreneur – and the importance of timing.

Heading out into the working world just as the recordable compact disc (CD-R) industry emerged, Vanessa quickly saw an opportunity to supply the demand for the solvent essential to the manufacturing process, investing HK$20,000 to order her first shipment from Taiwan. Shortly after the solvent arrived, Taiwan was hit by a major earthquake. Other suppliers' orders could not reach Hong Kong, and customers only had her company to help them.

Vanessa also realized the value in adopting a business strategy of becoming a sole agent, visiting the United States three times to make her case in person before she succeeded. She then invested in a chemical plant in Mainland China to be able to source the solvent at a lower price. In 2003, when a key Japanese solvent supplier suffered a fire, a global shortage resulted, increasing the selling price of solvent 10-fold, and Vanessa suddenly saw her company flooded with orders.

In 2017, Vanessa established Pure Living to create her own brand, serving as Chief Executive Officer of the innovative firm that sought to change the chemical industry mindset by introducing green technologies to chemical laboratories.

However, it has been COVID-19 that has brought the greatest challenges, after she decided to produce surgical masks. Refusing to compromise on standards but unable to obtain quality-guaranteed melt-blown fabric, she decided to produce the cloth herself. With the help of expertise from professors at Vanessa's alma mater and other local institutions, the company finally built its own machine – only to find the market already saturated with masks.

Vanessa Ho has launched her own brand to bring green technology approaches to the chemical industry.

Still, Vanessa has no regrets, seeing it as a living example of her personal philosophy. "Don't be afraid of falling down, be conscious when you are at your peak, always be attuned to the possibility of a crisis, and be prepared to cope with adversity," she said.

Meanwhile, she has already moved on to another venture: creating a new kind of yeast for handcrafted beer, in collaboration with HKUST.

◄ *cont. from P25*

Hard work followed as they carried out the test. But in less than a month, they proved the antimicrobial effect could last more than two hours on the skin, which was consistent with their design. The first batch of products – 10,000 bottles – was then produced, with the hand sanitizer now on sale in retail outlets.

Andy fully recognizes and is grateful for the teamwork involved, not only with his fellow students but the essential roles that Prof. Liu and Vanessa played. "They helped a lot in building up the product design and manufacturing the hand cream, as well as solving various real-life problems on marketing, testing, and commercializing."

Noting it had been "an intense and challenging summer", it had also been an amazing time for a final-year student turned fresh graduate and "an extraordinary experience for me", Andy said.

Greater Bay success story

Leadership skills developed at HKUST and an ability to seize opportunities and embrace change have resulted in alumna Eva TSANG Chin-Lam (1999 BEng in Chemical Engineering) being recognized with a Greater Bay Area Outstanding Women Entrepreneur Award 2020.

With a goal in life to learn as much as she could, in the early years of the new millennium Eva saw there were openings in Mainland China for engineers. In 2004, she joined Opal Cosmetics (HK) Ltd., where she has since risen up the ladder to her current position of Executive Director.

She sees her recent accolade as a recognition of her 15-plus years of hard work and business achievement at the company.

Working at Opal, a personal care and beauty products manufacturer that sells its own brands as well as producing goods for other companies, has meant being mostly based in Huizhou in Guangdong on weekdays, and only returning to Hong Kong at weekends. In fact, the past year spent totally in Hong Kong due to the COVID-19 pandemic was her first for a long time.

In the early days of her Opal career, Eva's cross-border lifestyle proved a challenge, having to adapt to numerous issues such as handling sudden power outages. However, her time at HKUST, then a new university, equipped her to take fresh adventures in her stride.

At the School of Engineering, she studied chemical engineering in the first department of its kind in Hong Kong. She also became the first female chairperson of the Engineering Students' Union, gaining experience in how to form and lead a team, and organize international events, encouraging her to widen her vision beyond Hong Kong.

Such experiences proved highly valuable in helping Eva establish herself at Opal, where she initially oversaw the company's original equipment manufacturing business in overseas markets. Meanwhile her chemical engineering degree meant she was familiar with formulations and the manufacturing involved in the company's products.

Eva Tsang has always been ready to seize opportunities and embrace wider horizons.

Now part of the company's senior management overseeing operations and management in sales and marketing, Eva regards care for employees as a key factor in a company's long-term development. It is an approach that has helped the business not only survive but thrive during the pandemic, which has been the most difficult period of her career, she noted.

With crisis management to the fore, the company switched to personal protective equipment (PPE) in response to market needs. "I realized we could no longer focus on our regular business and had to immediately pivot and devote ourselves to the introduction of PPE products."

Despite the challenges in logistics and marketing as well as safety issues, the company's business has been able to grow, while Eva has had the joy of seeing the resilience and agility of her team in adapting to rapidly unfolding market circumstances.

She also remains positive about Hong Kong's ability to overcome the economic difficulties it currently faces. The city has survived many such dips over the decades, she noted, through being able to "find opportunities and go on with hope".

At the Greater Bay Area Outstanding Women Entrepreneur Awards 2020 ceremony, with colleagues and friends.

Alumni

Ir. Samantha KONG Wing-Man (2014 BEng in Chemical and Environmental Engineering) has been named the inaugural Institution of Engineering and Technology (IET) Hong Kong Young Woman Engineer of the Year in the open category (pictured left). The IET accolade is the first locally presented award to honor outstanding young women engineers who have made valuable contributions to society. Samantha is a senior engineer at Arup, now leading an infrastructure sustainability team delivering green building projects and sustainability design in Asia and the Middle East. **Melody WONG Yee-Ting** (2018 MSc in Intelligent Building Technology and Management), also working at Arup, received a merit award.

Dr. QIN Tong (2019 PhD in Electronic and Computer Engineering) has been hired by global information and communications technology infrastructure giant Huawei as a research engineer through its highly selective "Top Young Talents" Scheme. The scheme also provides top salaries for successful candidates, with Tong being one of just four worldwide to be chosen to join at the highest multimillion-dollar annual salary level.

Ir. Billy WONG Chi-Pan (2005 BEng in Industrial Engineering and Engineering Management), now a Building Information Modeling specialist, was elected a BIMer 2020 by the Construction Industry Council. He has contributed to more than 16 iconic projects, including OPUS Hong Kong by Frank Gehry and Dongdaemun Design Plaza in South Korea by the late Zaha Hadid.

Integrated circuit (IC) design company SmartSens Technology, founded in 2011 by **Dr. XU Chen** (2004 PhD and 2001 MPhil in Electrical and Electronic Engineering), received three major accolades at the 2020 China IC Leaders Summit and China IC Design Achievement Awards. Dr. Xu's company was honored among the Worldwide Silicon 100, and with Achievement Awards in both the Microelectromechanical Systems (MEMS) category and as an IC Design Company with Outstanding Technology Support.

Dr. YAO Quanming (2018 PhD in Computer Science and Engineering) has been named in the 2020 Forbes 30 Under 30 China list, which recognizes young entrepreneurs and changemakers. Quanming is a tenure-track assistant professor in the Department of Electronic Engineering, Tsinghua University.

Philip YEUNG Wai-Lok (2015 BEng in Logistics Management and Engineering) has won the CILTHK Young Achiever Award 2020. The award is presented by the Chartered Institute of Logistics and Transport in Hong Kong (CILTHK). Philip is a project manager in operations consulting at Arup.

Faculty

External honors



Prof. Tim CHENG Kwang-Ting (left), Dean of Engineering and Chair Professor of both Electronic & Computer Engineering and Computer Science & Engineering, **Prof. Khaled BEN LETAIEF** (center), New Bright Professor of Engineering and Chair Professor of Electronic and Computer Engineering, and **Prof. ZHANG Qian** (right), Tencent Professor of Engineering and Chair Professor of Computer Science and Engineering, have been elected 2020 Fellows of the Hong Kong Academy of Engineering Sciences. In addition, Prof. Cheng has been honored with a Pan Wen Yuan Foundation Award for Outstanding Research in recognition of his international contributions to very large scale integration (VLSI) testing and design verification, and related research areas. Prof. Ben Letaief has been elected an international member of the US National Academy of Engineering. He has also been named the Best Tunisian Researcher or Inventor Abroad, a prestigious national honor in Tunisia.


Prof. Gary CHAN (left), Computer Science and Engineering, and **Prof. YEUNG King-Lun** (right), Chemical & Biological Engineering and Environment & Sustainability, have received the Chief Executive's Commendation for Community Service in Hong Kong's 2020 Honours List for their outstanding contributions to the fight against COVID-19. Prof. Chan was commended for his innovative geo-fencing technology used to implement Hong Kong's compulsory home quarantine order. Prof. Yeung's novel antimicrobial sanitizer has enabled large-scale disinfection of diverse premises in the city.

Prof. Pascale FUNG, Electronic and Computer Engineering, has been elected a 2020 Fellow of the Association for Computational Linguistics for her significant contributions toward statistical natural language processing, comparable corpora, and building intelligent systems that can understand and empathize with humans.


Prof. Francesco CIUCCI (left), Mechanical & Aerospace Engineering and Chemical & Biological Engineering, and **Prof. YANG Jinglei** (right), Mechanical & Aerospace Engineering, have been named Fellows of the Royal Society of Chemistry. The honor is conferred on individuals who have made major contributions to chemistry. Prof. Yang has also been elected a Fellow of the Royal Aeronautical Society, in recognition of his outstanding contributions to education, research, and service in aeronautics and related engineering sectors.

Prof. CHEN Qing, Mechanical and Aerospace Engineering, was named a 2020 Excellent Young Scientist by the National Natural Science Foundation of China. The award is one of the most prestigious for young academics in China. He will receive RMB1.2 million over three years to conduct pioneering research on the percolation dissolution mechanism and nanoporous metals for electrochemical energy storage.

Prof. KWOK Hoi-Sing, Electronic and Computer Engineering, has been elected a 2020 Fellow of the National Academy of Inventors, which is dedicated to encouraging inventors in academia and the highest professional distinction accorded solely to academic inventors. Prof. Kwok is an expert in display technologies and nanotechnologies, holding more than 90 patents.

Prof. LI Zexiang, Colin Lam Ko Yin Professor of Engineering and Electronic and Computer Engineering, was selected as one of 40 model innovators and entrepreneurs for the 40th anniversary of the establishment of the Shenzhen Special Economic Economic Zone by the Shenzhen Municipal Committee of the Communist Party of China and Shenzhen Municipal People's Government. Honorees have made distinguished contributions in driving the development of the area over the past 40 years.

Prof. Matthew MCKAY, Electronic & Computer Engineering and Chemical & Biological Engineering, has been elected a 2021 Fellow of the Institute of Electrical and Electronics Engineers (IEEE), bringing the total number of Fellows among School of Engineering faculty members to 42. Prof. McKay was recognized for his contributions to random matrix theory in statistical signal processing.

Prof. Charles NG (left), CLP Holdings Professor of Sustainability, Chair Professor of Civil and Environmental Engineering, and Dean of HKUST Fok Ying Tung Graduate School, has been named a 2020 Fellow of the Royal Academy of Engineering, and **Prof. HUI Pan** (right), Computer Science and Engineering, an International Fellow in recognition of their outstanding and continuing contributions to the profession.

New appointments

Administrative

Prof. Lionel NI
Appointed Founding President of HKUST (Guangzhou) (effective date to be announced)
Provost of HKUST, to May 31, 2021
Chair Professor, Computer Science and Engineering

Prof. PONG Ting-Chuen
Appointed Vice-President for Administration and Business (effective July 1, 2021)
Professor, Computer Science and Engineering

Prof. Charles NG
Appointed Dean of HKUST Fok Ying Tung Graduate School
Chair Professor, Civil and Environmental Engineering

Prof. ZHANG Limin
Appointed Head of Department of Civil and Environmental Engineering (effective July 1, 2021)
Chair Professor, Civil and Environmental Engineering

Prof. Andrew POON
Appointed Head of Department of Electronic and Computer Engineering (effective July 1, 2021)
Professor, Electronic and Computer Engineering

Prof. Tim WOO
Appointed Associate Director and Academic Director (Undergraduate Core Education) of Center for Education Innovation
Associate Professor of Engineering Education, Electronic and Computer Engineering

Faculty

Prof. Tristan BRAUD
Assistant Professor, Integrative Systems and Design
PhD – University Grenoble Alpes

Prof. CHEN Hao
Assistant Professor, Computer Science and Engineering
PhD – The Chinese University of Hong Kong

Prof. YANG Hai, Chair Professor of Civil and Environmental Engineering, received the 2021 Francis C. Turner Award from the American Society of Civil Engineers (ASCE). He was recognized for his outstanding leadership in the fields of transportation network modeling and transportation economics, as well as his record in both research and mentoring.

Prof. Jack CHENG, Civil and Environmental Engineering, received two accolades at the Construction Industry Council's BIM Achievement Awards 2020, which recognize outstanding performance in Building Information Modeling (BIM). Prof. Cheng received recognition in the projects category for his "Digital Twin for HKUST Campus" initiative that supports the University's smart campus development, and in the organization category for the HKUST BIM Lab, which he directs.

HKUST

Prof. Raymond WONG, Computer Science and Engineering, was awarded the prestigious Michael G. Gale Medal for Distinguished Teaching in 2020. The honor is presented annually to the faculty member who best exemplifies the continued pursuit of excellence as an educator from across all Schools at HKUST.

Four faculty were honored in the School of Engineering Teaching Excellence Appreciation Awards 2019-20. The Distinguished Teaching Award was presented to **Prof. David ROSSITER** (left), Computer Science and Engineering. Teaching Awards went to **Prof. Ben CHAN** (center), Civil and Environmental Engineering and Director of the Center for Engineering Education Innovation, **Prof. Henry LAM** (right), Chemical and Biological Engineering, and **Prof. Raymond WONG** (above entry), Computer Science and Engineering.

Prof. FU Lin
Assistant Professor, joint position in Mechanical & Aerospace Engineering and Mathematics
PhD – Technical University of Munich

Prof. GAO Hanyu
Assistant Professor, Chemical and Biological Engineering
PhD – Northwestern University

Prof. Amir GOHARSHADY
Assistant Professor, Computer Science and Engineering
PhD – Institute of Science and Technology Austria

Prof. Mitch LI
Assistant Professor, joint position in Integrative Systems & Design and Electronic & Computer Engineering
PhD – The University of Hong Kong

Prof. LI Xiaomeng
Assistant Professor, joint position in Electronic & Computer Engineering and Computer Science & Engineering
PhD – The Chinese University of Hong Kong

Prof. Lionel PARREAUX
Assistant Professor, Computer Science and Engineering
PhD – Swiss Federal Institute of Technology, Lausanne (EPFL)

Prof. Vinod PRASAD
Professor of Engineering Practice, Electronic and Computer Engineering
PhD – Nanyang Technological University

Prof. XU Dan
Assistant Professor, Computer Science and Engineering
PhD – University of Trento

Prof. YANG Shuoguang
Assistant Professor, Industrial Engineering and Decision Analytics
PhD – Columbia University

Prof. ZHOU Xiaofang
Chair Professor, Computer Science and Engineering
PhD – The University of Queensland

Entrepreneurs offer insight to next generation

The online Fireside Chat Series on entrepreneurship, venture capital, and start-ups kicked off with Alfred Chuang (left) and has since featured Zhang Yunfei (center) and Edith Yeung.

To inspire Hong Kong's technology leaders of the future, the School of Engineering has launched the HKUST Entrepreneurship Fireside Chat Series, featuring successful tech entrepreneurs, who share their experience, vision, and ideas in interactive online discussions.

The webinars have proved popular, with hundreds of University members and viewers from the wider community tuning in to take part in the sessions.

At the most recent event in December 2020, alumnus Dr. ZHANG Yunfei (2020 PhD and 2009 MPhil in Mechanical Engineering), who has set up China's first unmanned surface vehicles company, related some of the challenges involved in starting and sustaining an enterprise. The Founder and President of Zhuhai Yunzhou Intelligence Technology Ltd. recommended would-be entrepreneurs adopt a "T-shaped" approach: horizontally broadening their business skill set while vertically deepening their knowledge of their chosen field to facilitate business growth and development. Dr. Zhang also donated two "Dolphin 1" surface rescue vehicles to the University to assist future learners and made the vehicles' software available for students to explore.

Earlier, Mr. Alfred CHUANG, an accomplished Hong Kong entrepreneur, venture investor, and company advisor, kicked off the series in June 2020 with a discussion on the impact of the COVID-19 pandemic on start-ups, the importance of adaptability in a rapidly changing world, and the opportunities for technological innovations that often came from a crisis.

This was followed in July 2020 by a talk with Ms. Edith YEUNG, an experienced venture capitalist and technology executive, who has invested in over 2,000 companies. Ms. Yeung looked at building a global "unicorn" (a privately held start-up with value over US$1 billion) in Hong Kong. In her advice to young founders seeking investment, she suggested they need to be prepared to answer questions on the "metrics" involved in their business, such as retention rate or monetization method for consumer start-ups or sales cycle for a business-to-business enterprise. She also highlighted the importance of being passionate and genuine about their idea.

All three sessions were introduced by Dean of Engineering Prof. Tim CHENG and moderated by Adjunct Prof. Jack LAU, Electronic and Computer Engineering. Prof. Lau was the University's first PhD graduate and is an entrepreneur himself.

Dean of Engineering Prof. Tim Cheng (left) and alumnus and entrepreneur Prof. Jack Lau hosted the sessions.