# INFOCUS

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HKUST ENGINEERING SPRING 2020

# Technology to the Rescue

## Novel Solutions to Fight COVID-19

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

工學院
SCHOOL OF ENGINEERING

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# Crises to opportunities

From Hong Kong's social unrest to the global COVID-19 crisis, the 2019-20 academic year has been unprecedented for higher education in the city.

To look after our students, the School of Engineering moved swiftly to extend earlier moves toward blended learning – a mix of face-to-face instruction and online or digital course components – to successfully deliver a full complement of interactive online teaching during the virus-affected Spring 2020 semester.

We proactively trained faculty in online methodologies and interaction while keeping to class schedules as originally planned, and were rewarded with notable results, including feedback surveys that showed that the majority of students have been satisfied with such virtual practices. Indeed, I now see a fascinating window of opportunity where mindsets on both the teaching and learning sides become ready and willing to embrace new engineering education approaches, having experienced for themselves how effective these methods can be.

I am also immensely proud of the immediate response and willingness of the School's faculty and alumni to adapt and roll out novel research-based applications that have contributed to prevention and mitigation of the pandemic in Hong Kong and beyond.

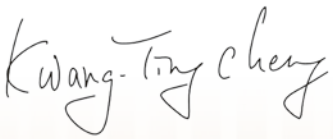
As our Cover Story shows, the School has produced not one but a host of innovative technologies in areas ranging from mass temperature screening and early vaccine target identification to self-driving delivery vehicles in locked-down areas and computer modeling demonstrating the significance of populations' widespread use of face masks.

Such scope is evidence of the wide-reaching and relevant research being pursued at the School, the impact it can generate, and the essential role of engineering in managing complex crises. This time we have faced an implacable disease. Tomorrow, it could be climate change or IT security issues that require immediate action.

What it also demonstrates is the need for investment in research over the long term in order to be prepared for emergencies. For the technologies that our faculty members have been able to deploy were not created in an instant but are the result of years of careful, continuous discovery and development.

Alongside our response to the pandemic, the School has been deeply involved in planning and advancement of HKUST's visionary Guangzhou campus, scheduled to open in 2022. Rather than discipline-specific schools and departments, HKUST(GZ) will be structured around a pioneering hub concept, namely the areas of function, information, systems, and society. These hubs will be driven by multidisciplinary thinking and collaboration, technology transfer, and impact, with engineering fields having a strong presence in all four.

Teaming this cutting-edge approach in a complementary way with the University's already established global research leadership and recent online interactive teaching and learning insights, the future certainly looks exciting for HKUST engineering.



**Prof. Tim CHENG Kwang-Ting**
*Dean of Engineering*

# 400 faculty sought for Guangzhou campus

Faculty recruitment for Hong Kong University of Science and Technology (Guangzhou) (HKUST(GZ)), the University's new campus is now underway. Some 400 top minds are being sought from around the world over the next six years to take forward phase one of the pioneering research and education concepts and environment planned.

An artist's impression of HKUST's new Guangzhou campus that seeks to lead the way in research and education concepts and sustainable design.

Over 300 scholars in the US and Europe tuned in to a University webinar in April 2020 in which HKUST senior management introduced the visionary development blueprint for HKUST(GZ). The campus will be located in Qingsheng, Nansha, near Guangzhou, with the first phase scheduled to open in mid-2022. More faculty are due to be recruited as the campus continues to develop.

Unlike a traditional university divided into separate academic fields and departments, HKUST(GZ) will operate under four interconnected, multidisciplinary hubs (function, information, systems, society), each with research thrust areas focusing on key emerging areas, for example, robotics & autonomous systems, data science & analytics, and internet of things.

The goal is to address the growing need for today's complex global challenges, such as climate change and renewable energy, to be solved through multi-field input, interaction, and synergy and to facilitate the transfer of academic research to society. The two campuses will be complementary to each other, with no duplication of programs and students awarded degree certificates from both.

The purpose-built design of HKUST(GZ), created by internationally renowned architectural firm Kohn Pedersen Fox Associates, will reflect this cutting-edge approach, marrying technology with sustainability.

The School of Engineering is playing a key role in the new campus, with two of the four hubs under the acting deanship of two of its long-serving senior academics: Prof. Ricky LEE (systems) and Prof. Fugee TSUNG (information).

# HK$40m donation to boost students' 360° vision

The School of Engineering's Student Innovation for Global Health Technology (SIGHT) program has become the first project to be supported by a HK$40 million donation from the Seal of Love Charitable Foundation, an organization founded by Lawrence Chan and his family that is focused on assisting education and the underprivileged in Hong Kong and Southeast Asia.

The donation has been used to establish the Seal of Love Foundation Student Innovative Service Fund at HKUST. The objective of the endowment fund is to empower students to apply innovative thinking and technology know-how to solve global health problems around the world, particularly in communities with limited resources, and to deliver social impact through tangible solutions.

SIGHT is an undergraduate innovation platform, launched in 2014 to inspire students from different majors and backgrounds to devise creative and affordable solutions to global health problems. Inventions deployed to date, in collaboration with other organizations, include diagnostic software for diabetic retinopathy in Indonesia and a

# Artificial intelligence global leaders

The School of Engineering (SENG) has seen nine faculty members and several alumni included among the world's leading researchers in artificial intelligence (AI) in the 2020 AI 2000 Most Influential Scholar Annual List, released by Tsinghua University.

The 2020 AI 2000 recognizes top-cited AI research scholars globally over the 10 years from 2009-19 and covers 20 sub-fields. Researchers in the top 10 of each sub-field are named "most influential scholar" while those from 11-100 are accorded an "honorable mention".

Two SENG academics feature in the world's top 10 in two separate sub-fields. Prof. YANG Qiang, Chair Professor of Computer Science and Engineering, was ranked No.1 in the Association for the Advancement of Artificial Intelligence Conference/International Joint Conference on Artificial Intelligence (AAAI/IJCAI) section and No.43 in information retrieval and recommendation. Prof. QU Huamin, Computer Science and Engineering, ranked No.3 in visualization.

Faculty awardees are listed^ in the table. At least four PhD alumni from the Departments of Computer Science & Engineering and Electronic & Computer Engineering were also included in the sub-fields of internet of things and AAAI/IJCAI.

The results were announced by Tsinghua-Chinese Academy of Engineering's Joint Research Center for Knowledge and Intelligence and Tsinghua's Institute for Artificial Intelligence.

The list is automatically determined by computer algorithms through Tsinghua's AMiner data system, which tracks and ranks scholars based on citation counts from leading publications. The system tracked and analyzed research results for 250,669 scholars worldwide over a decade from 2009, covering 140,377 papers and including 43 top conferences and journals.

| | | |
|---|---|---|
| **Department of Computer Science & Engineering** | | |
| Prof. James KWOK | AAAI/IJCAI | 21 |
| Prof. QU Huamin | Visualization | 3 |
| Prof. YANG Qiang | AAAI/IJCAI | 1 |
| Prof. YANG Qiang | Information Retrieval and Recommendation | 43 |
| Prof. ZHANG Tong* | Machine Learning | 68 |
| Prof. ZHANG Zhengyou† | Multimedia | 46 |
| **Department of Electronic & Computer Engineering** | | |
| Prof. Khaled BEN LETAIEF | Internet of Things | 28 |
| Prof. Vincent LAU | Internet of Things | 51 |
| Prof. SHEN Shaojie | Robotics | 73 |
| Prof. ZHANG Jun† | Internet of Things | 27 |

^ alphabetical order
* joint appointment with Department of Mathematics
† adjunct faculty


HKUST senior management and Seal of Love Charitable Foundation members at the naming ceremony.

keyboard for students with special educational needs in Hong Kong.

SIGHT forms one of five wide-ranging units under the School of Engineering that promote students' all-round development through activities beyond the regular curriculum and cover areas from internship to global and community engagement.

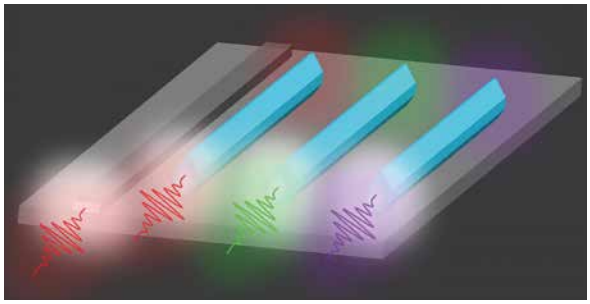
A section of the University's Academic Building has been named the "Seal of Love Charitable Foundation Wing" in appreciation of the Foundation's generous support.

# Silicon photonic integrated circuit breakthrough

A significant global optoelectronic advance by a School of Engineering research team has brought the prospect of major improvements to the infrastructure of high-speed network communications in data centers one step closer. The breakthrough could potentially lead to faster, cheaper services as well as novel applications once practically applied and integrated.

The researchers, led by Chair Professor Kei May LAU, Fang Professor of Engineering, and postdoctoral fellow Dr. HAN Yu, both Electronic and Computer Engineering, have developed 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 heralds a way forward for achieving the long-sought and challenging goal of fully integrated silicon (Si)-based photonic integrated circuits with truly on-chip laser sources.

As efficiencies in conventional pure electron-based data systems might not be able to keep pace with the huge growth of data traffic as internet-based services and digitalization continue to expand exponentially, the HKUST development could enable photonic integrated circuits that are capable of much greater speed, power efficiency, and cost-effectiveness, as well as facilitate new functionalities and applications.



Schematic of III-V laser array directly grown on silicon photonic 220-nanometer silicon-on-insulator platform.

Prof. Kei May Lau's development could lead to much faster and more power-efficient photonic integrated circuits.

Prof. Lau's group, based in HKUST's Photonics Technology Center, has spent over 10 years exploring how to integrate III-V materials and functionalities on mainstream silicon wafers. Through continuous innovation and optimization to improve the performance of III-V lasers grown on Si, the team has moved the research forward toward industry requirements. The research findings were published online in *Optica* earlier this year.

# Young entrepreneurs recognized

Two School of Engineering alumni have separately gained places on the Forbes 30 Under 30 Asia 2020 list of young entrepreneurs and changemakers. The list comprises 300 young leaders under 30 years of age, chosen from 3,500 nominations in 10 different categories.

EventXtra's Angus LUK Kai-Chit (2012 BEng in Computer Science) was included in the enterprise technology category. He co-founded the event management software company with WONG Cheuk-Sum (2013 BEng in Computer Science). Winston WONG (2014 BEng in Computer Engineering) was listed in the finance and venture capital category for co-founding Qupital, a trade finance platform for small and medium-sized enterprises.

The alumni were selected after vetting by a panel of judges comprising accomplished entrepreneurs in each category. Criteria for the list included demonstrated leadership and potential of success in their industry, with innovation and disruption also taken into account in final decision-making. Both start-ups are members of the Cyberport Incubation Programme in Hong Kong.

Angus Luk (top picture) and Winston Wong were chosen from 3,500 nominations to join this year's Forbes 30 Under 30 Asia list of changemakers.

Tree sensors installed on *Peltophorum tonkinense* at the HKUST campus to monitor tilt and stability (main picture), and (above) a close-up of the technology.

# Branching out into smart conservation

Effective tree management is a long-term public concern in Hong Kong. Thousands of trees are located across the city's densely populated urban areas and country parks, including 500 old and valuable trees that are government registered. All are subject to damage caused by rainstorms, typhoons, and diseases, among others, and could pose a risk to people's safety.

To assist the quest for sustainability and protection, Prof. WANG Yu-Hsing, Civil & Environmental Engineering and Data-Enabled Scalable Research Laboratory (DESR Lab), is creating smart and innovative ways to monitor a tree's tilt and associated stability. A major goal is to provide information about arboreal resilience and tenacity in response to bad weather conditions – anticipated to be increasingly frequent due to climate change.

Starting out from a student project using sensing technology on slopes in 2013, Prof. Wang and his team are now designing and making their fourth-generation tree sensor, which will harvest energy from solar panels and uses artificial intelligence (AI) to carry out data analytics.

"What we ultimately aim to achieve is to let AI provide a more solid diagnosis for tree health," Prof. Wang said. "Even if a tree is seemingly unhealthy, our sensor can continue monitoring it in order to allow it to recover instead of removing it at once."

The benefits of such sensors include easing the workload of the city's hundreds of arborists, who could be trained how to operate the whole sensing system and whose feedback would also help fine-tune the device.

With funding secured from the Hong Kong Jockey Club Charities Trust in early 2018, Prof. Wang's team began work on a sensor that used a low-power, long-range wide area network (LoRaWAN) for transmitting data in real time and at the same time would be energy-efficient. Big data analytics and timely interventions could then be carried out.

During this research period, the team devised different generations of sensors, eventually managing to quadruple the data transmission range.

The researchers' work then had a considerable boost in terms of data collection in summer 2018 when the Hong Kong Observatory forecast the arrival of Typhoon Mangkhut, the strongest typhoon in the city's history. Ahead of time, the team installed sensors on trees at Tai Tong in Tai Lam Country Park and on some urban trees.

Mangkhut left Hong Kong with around 46,000 fallen trees but the team gained significant first-hand scientific data to analyze how and why some trees fell.

In late 2019, Prof. Wang and the DESR Lab joined HKUST's Sustainable Smart Campus as a Living Lab initiative, which supports sustainable cross-disciplinary HKUST projects that can be implemented on campus. He and the team are now continuing to develop their cutting-edge tree sensing system, Internet of Tree Things.

Prof. Wang Yu-Hsing (seventh from left) and team members from his Data-Enabled Scalable Research Laboratory.

# Boosting diversity, broadening vision

Prof. Albert Chung (center) enjoys meeting and gaining insights from students.

## Young engineers with a passion for their subject and understanding beyond the technical are the key to the future, says Associate Dean Prof. Albert Chung

With a love of meeting and talking to people, especially students, Prof. Albert CHUNG has recently been appointed to the perfect role: Associate Dean of Engineering (Undergraduate Studies), driving forward admissions, quality assurance, exchange programs, and the curriculum at the School of Engineering (SENG).

Always ready to seek out student interaction, be it through interviewing potential non-local recruits, or feedback on current courses, he can learn and gain valuable insights on how to keep the School's education at the cutting edge.

Prof. Chung is a great believer in the benefits of diversity – the School already draws its intake from 33 countries and regions – and prior to the onset of COVID-19 he had a busy travel schedule planned to inspire top young minds from around the region to join SENG. He is looking out for students with a passion for their chosen engineering field, seeing such enthusiasm as a core element in a readiness to share knowledge across disciplinary boundaries to spark wider vision, fresh thinking, and innovation.

He would also like to build even more exchange partnerships beyond the current 28 countries and regions that enable around 40% of SENG students to study and see beyond Hong Kong, viewing it as essential for engineering students to understand life beyond the technical and local. "Engineering must work hand in hand with other disciplines," he said. "For instance, an engineer can build a bridge, but in choosing the location, other considerations must be taken into account."

He himself is a great example of a multidisciplinary mindset, specializing in the burgeoning area of medical image analysis and holding joint appointments in the Departments of Computer Science & Engineering and Chemical & Biological Engineering.

Following undergraduate studies in computer engineering at the University of Hong Kong, broadened by a keen interest in sports and student associations, he spent a year in industry at Procter & Gamble before undertaking an MPhil in Computer Science at HKUST in 1996.

Prof. Chung had been inspired to go to HKUST, established in 1991 and at the time still regarded as a new university, during his undergraduate days, after being impressed by a hall of residence dinner talk by HKUST Founding President Prof. WOO Chia-Wei on improving the student experience.

The benefits of all-round vision were reinforced at the University of Oxford, where he relished the human interaction and interdisciplinary collaboration during his DPhil in Engineering Science, supported by a prestigious Croucher Foundation Scholarship. He started at HKUST as an assistant professor in 2002 and became a full professor in 2014. Prof. Chung has also spent 13 years serving as a residence master.

He sees HKUST's resources, approach and student diversity as creating a thriving environment in which to grow and is keen to add to such an atmosphere. "Know your direction and walk toward it bit by bit every day" is one of his guiding principles to achieving goals. Talking can help too.

# Assisting students to know themselves

By Prof. Song Shenghui

Learning comprises two competing elements: outside guidance and self-exploration (AI learns with or without supervision, which is not a coincidence). Conventional engineering education puts more emphasis on the first aspect, while so-called innovative teaching methods such as flipped classrooms, where learners first study materials themselves and use time in class to practice or discuss the subject, seek a better balance by giving students more freedom to explore.

In my opinion, the top priority of engineering education should be the provision of a platform for students to understand the changing world, and themselves, to unlock their potential and build up their core strengths.

The key to building such a platform is not only to teach discipline knowledge and skills (guidance) through lectures but more importantly to give students a chance to experience failure and success, and to reflect on both in order to identify and build up their individual strengths. Educators may think themselves highly important, but ultimately students learn from their experience, not teaching (AI also learns from data, again not a coincidence).

As a teacher, I thus regard myself as a designer whose product facilitates learning.

***"Educators may think themselves highly important, but ultimately students learn from their experience"***

At HKUST, especially in the School of Engineering, we have been proactively developing a diversified student learning experience, including blended learning strategies such as the aforementioned flipped classrooms, Massive Open Online Courses (MOOCs), and project-based learning, among others. Another example is the new Division of Integrative Systems and Design, an endeavor to advance learning through active teaching pedagogies and transdisciplinary learning. Although it is difficult to quantify the effectiveness of any learning method, I believe we are on the right track to create a more diverse learning experience, providing opportunities for students to learn how to learn under different circumstances.

The COVID-19 pandemic has affected everyone's life, including teaching and learning practices in universities. We all understand that converting every type of learning activity to online teaching is impossible and a more serious issue for engineering schools, where many project and lab-based courses need to be carried out. Fortunately, with enterprising efforts on both the teaching and learning sides, our School has been able to move on while maintaining its established quality.

Looking forward, engineering education will face more challenges, which may not be bad news because that is exactly what our students will face in their careers: a fast-changing world. In recognizing this need for on-going evolution of learning, hopefully the training at HKUST will provide our students with the ability to deal with change, to learn new things, and to preserve mental balance in novel situations.

21st century engineers

Prof. SONG Shenghui is Associate Professor of Engineering Education in the Department of Electronic and Computer Engineering. He is a past winner of HKUST's University-wide Michael G. Gale Medal for Distinguished Teaching, School of Engineering Distinguished Teaching Award, and a recipient of the student-organized Best Ten Lecturers of HKUST multiple times. He is also an associate editor for *IEEE Transactions on Education*.

# An eye on the future

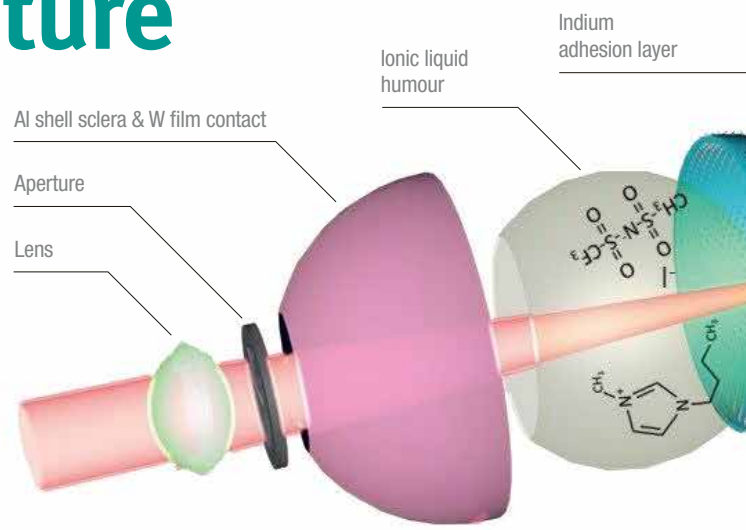
## Prof. Fan Zhiyong's science fiction-inspired research into biomimetic vision points the way to robotics advances and fresh hope for the visually impaired, in addition to a prestigious *Nature* article

Prof. FAN Zhiyong, Electronic and Computer Engineering, has always drawn inspiration from the cosmos and science fiction. As a preschooler, he created 100 paper models of spacecraft and vehicles after seeing a poster with Planet Earth, spaceships, and astronauts on his kindergarten wall. Now in his 40s, he has recently celebrated his 10th anniversary at HKUST by achieving a high-profile publication in *Nature*, a leading global science journal, with his research team. The article is based on Prof. Fan's far-sighted idea for improving the capabilities of artificial eyes after watching *Star Trek*, *I, Robot*, and other out-of-this-world series.

"I thought about making a 'super human eye' to be used both in humanoid robots and for the visually challenged," he said. "My students thought it was yet another crazy idea of the professor." Instead, it turned out to a visionary advance, leading to the *Nature* article, "A Biomimetic Eye with a Hemispherical Perovskite Nanowire Array Retina", published in May 2020.

Since the article appeared, authored by his research team and collaborators from the University of California, Berkeley, he has been inundated with emails about the invention: the world's first spherical artificial eye with three-dimensional retina, also referred to as the Electrochemical Eye.

Prof. Fan Zhiyong and the scenic campus that helped to draw him to HKUST.



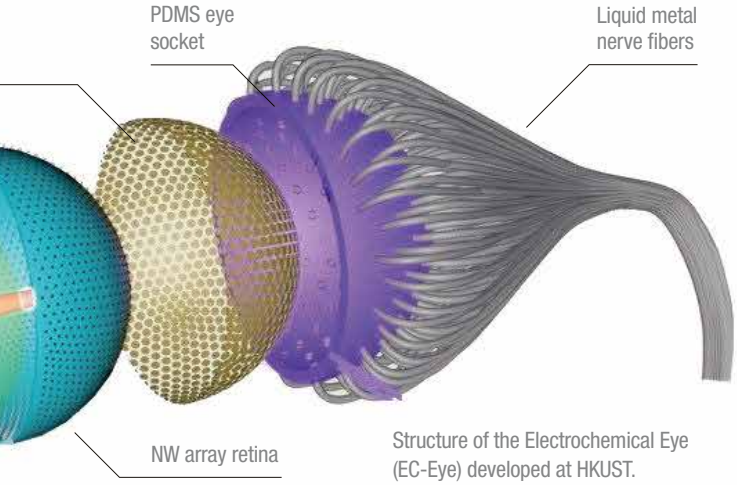

As the publication notes, the spherical human eyeball gives us an exceptionally wide field of view, high resolution, along with other qualities. Such a field of vision is extremely useful, Prof. Fan said, but difficult to replicate due to its curved surface.

"Artificial eyes, currently used in hospitals and enabled by flat-surfaced integrated circuit chips, can only imitate part of the human retina, providing blurred vision. In 2012, I came up with the idea to use nanowires and external electronic circuitry to enable high-density sensors on a curved surface. The resulting biomimetic eye prototype has 30 times more sensors on the entire artificial retina than the human eye."

This technology, with its ability to deliver high-resolution imaging and sensitivity to a large range of light intensities as well, can be integrated into medical robots to take care of patients. It could also cater to the visually impaired when the researchers locate suitable bio-compatible materials, Prof. Fan said.

The leading researcher joined HKUST in 2010 and has since focused on nanoelectronic design, nanofabrication, and nanomaterials, including development of self-cleaning and anti-reflection micro/nanostructured films, a study of nanostructured gas sensing materials and devices for environmental monitoring, as well as his recent artificial eye prototype. "I was attracted by HKUST's global ranking, as well as its flat hierarchy and academic freedom. And, after the first glimpse of the sea view here, I decided that this was the place to be," he said.

Born in remote Qinghai province in Mainland China, Prof. Fan's family moved to a small county in Shaanxi province before he was eight. There, he engaged in weekly visits to his uncle's bookshelves to read popular books on science, gradually gravitating toward self-learning ahead of what




Structure of the Electrochemical Eye (EC-Eye) developed at HKUST.

An artistic image of the artificial eye.

was taught in school before earning full marks in physics in the country's national Joint Entrance Examination and becoming one of the few students from Shaanxi to gain a place at esteemed Fudan University in Shanghai.

After majoring in Physical Electronics, a rare interdisciplinary program at Fudan, he went on to a PhD in Interdisciplinary Materials Science at the University of California (UC), Irvine, before becoming a postdoctoral fellow in UC Berkeley's Department of Electrical Engineering and Computer Sciences. At Berkeley, he not only refined his research skills but broadened his attitude to the purpose of such exploration. "My supervisor encouraged us to be creative and to generate social impact. He often asked, 'What difference can we make?' This had a tremendous influence on me."

The proactive, hands-on outlook combined with discussion that Prof. Fan subsequently adopted has brought striking results for members of his own research team. The first author of the artificial eye publication was Dr. GU Leilei, a postdoctoral fellow and one of the earliest to work on the professor's "crazy idea". "Prof. Fan has completely changed my perspectives toward research," he explained. "I was more theoretical then, and now I have learned to combine a practical, formula-based approach with daring imagination."

Prof. Fan (left, standing) and team members (clockwise from center) Dr. Gu Leilei, Swapnadeep Poddar, and Long Zhenghao. After initial submission to *Nature*, the team spent almost a year, conducting further experiments and fine-tuning before the paper was accepted.

Such dynamic thinking is in line with Prof. Fan's belief that "nothing is impossible". "Always ask, 'How do we go from here to cutting-edge research?' Be driven and curious, be imaginative, and be humble and collaborative... Always challenge the result unless you have conducted experiments to verify it."

The viewpoint has also helped Prof. Fan rapidly build a high-powered academic career, securing more than HK$20 million in research grants from Hong Kong and Mainland China, publishing over 170 research papers in top journals, and winning multiple accolades. But to him, this is only part of the success story he has set his heart on accomplishing.

"I treasure it more when our technologies generate impact on society, when my students land good positions in top universities or become entrepreneurs, and when our research results are cited," he said. "Making a difference – this brings long-term satisfaction."

## Visible presence

Prof. Fan Zhiyong's many recognitions include:

- Fellow, Royal Society of Chemistry, 2018
- Founding Member, Hong Kong Young Academy of Sciences, 2018
- Highly Cited Researcher by Clarivate Analytics, 2018
- HKUST School of Engineering Research Excellence Award, 2018-19
- President Award and Innovation Award, HKUST One Million Dollar Entrepreneurship Competition, 2016
- HKUST School of Engineering Young Investigator Award, 2016


• online education
• vaccine candidates
• disinfection
• AI modeling and systems
• driverless lockdown delivery vans
• mask-wearing
• quarantine tracking
• fever screening

# Tackling COVID-19

School of Engineering researchers rapidly responded to the SARS-CoV-2 crisis, rolling out a host of innovations in the first six months of 2020 to address the health and social impact of the novel coronavirus. Such work, based on years of leading-edge research, has encompassed faculty, alumni, and students, and involved partnerships with industry, government bodies, philanthropic organizations, schools, and social welfare groups. Advances in engineering education have also taken place. The following pages highlight some of the significant solutions we have contributed to assist the local, national, and global community in combatting COVID-19.

# Safe and sanitized

Earlier this year, when many people in Hong Kong were working, studying, or simply staying at home due to the COVID-19 outbreak, a number of dedicated cleansing crews were out and about in many of the empty schools and community centers, preparing for when the usual inhabitants of these buildings could return. Their task? Large-scale and thorough long-term disinfection with a novel, non-toxic, and super-effective type of smart antimicrobial sanitizer, invented at the School of Engineering.

By early March 2020, assisted by an industrial partnership with Chiaphua Industries Ltd., disinfection of more than 70 day-care centers, elderly homes, kindergartens, primary and secondary schools as well as shopping malls, school buses, churches, and sports training facilities had taken place. The HKUST campus had also been sprayed.

Since April 2020, sponsorship by the Lee Hysan Foundation, a private family philanthropic organization that supports meaningful initiatives in sectors including education, health and social welfare in Hong Kong, has taken the technology further into the community by supporting the disinfection of over 1,000 caged home units and sub-divided flats that are often crowded with multiple occupants.

The creative mind behind the original technology is Prof. YEUNG King-Lun, Chemical & Biological Engineering and Environment & Sustainability, who has spent more than 15 years devising and optimizing the antimicrobial coating.

Spurred initially by the challenges presented during the SARS outbreak in 2003 and the need to be prepared should such a crisis present itself again, what started as a novel coating to decontaminate surfaces, such as lift buttons and counter tops, has gone on to generate products to combat diseases caused by the presence of pathogenic microorganisms in air and water as well.

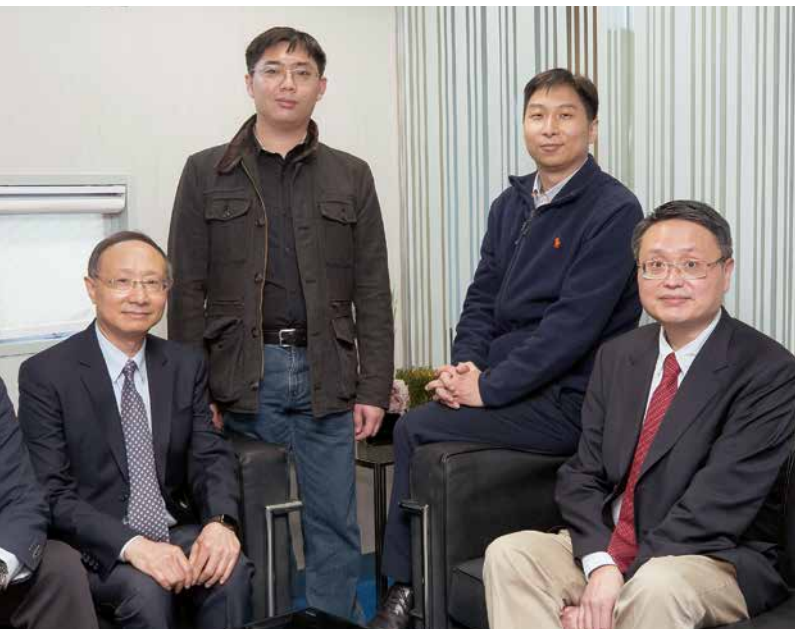
From the outset, Prof. Yeung has employed safe-by-design principles to ensure the materials used are non-toxic for both people and the environment. A close collaborator on the project is the founding and former Director of HKUST's Health, Safety and Environment Office Prof. Joseph KWAN.

Prof. Yeung's Multilevel Antimicrobial Polymer (MAP-1) coating is effective in inactivating up to 99.9% of highly infectious viruses such as measles, mumps and rubella, and 99.99% of the surrogate feline calicivirus (FCV) – a gold standard for disinfection efficiency and more resistant than coronaviruses such as the one responsible for the COVID-19 epidemic.

In addition, the coating provides long-lasting "smart" protection and surface disinfection against microbial contamination for up to 90 days by self-cleaning and self-disinfecting when touched or contaminated. Prof. Yeung has described this as "closing the loop on surface disinfection". Odorless and transparent, the versatile coating can be used on metals, concrete, wood, glass, and plastics, as well as fabrics, leathers, and textiles.

According to the Technical Standard for Disinfection issued by the National Health Commission in Mainland China, the coating has

A School of Engineering student ambassador (front) and University staff member (back) lend a hand with disinfecting Carmel Pak U Secondary School in Tai Po.



Members of the clean team: (from right), Prof. Yeung King-Lun, Prof. Han Wei, alumnus Donald Lai, Prof. Joseph Kwan, and Mr. Hamilton Hung, Chiaphua Industries Ltd.

proven to be non-toxic and is safe for skin and the environment. This means MAP-1 can be turned into products including hand sanitizers, paints and coatings, filter materials for air and water purification, along with clothing and surgical masks.

Chiaphua, a multinational industrial and consumer product manufacturer, is now producing the antimicrobial coating under the name Germagic Thyme 90, incorporating polyethylenimine and thyme essential oil.

Germagic is the first major spin-off from a joint laboratory established by HKUST and Chiaphua in 2018. The HKUST-CIL Joint Laboratory of Innovative Environmental Health Technologies is directed by Prof. Yeung, with the aim of accelerating the transfer of ideas and research to create products that benefit industry and society. A retail version of Germagic has already been launched.

The School's Engineering Student Ambassadors, who outreach to potential students and the public, have played their part, helping to spray schools.

Three of Prof. Yeung's previous MPhil students have also been involved as employees of Chiaphua. Donald LAI Yue-Tak's key duties include explaining the technical aspects and functionality of the products to internal team members and external clients, purchasing raw materials, and supervising mass production. Winsor LEE Jong-Hong still spends time at the HKUST lab, while LUO Yutang is employed at the Germagic air filter plant in Shenzhen. The alumni engage in product testing in response to clients' specific disinfection requirements and to comply with different international regulations.

Local, national, and international media coverage has been extensive, with more than 200 news articles and broadcasts since February 2020.

Prof. Yeung is not stopping there. The Hong Kong government has awarded funding to the Yeung team for two Innovation and Technology Fund Public Sector Trial Scheme (ITF PSTS)-COVID-19 projects involving Haven of Hope Christian Service, Tung Wah Group of Hospitals, and United Muslim Association of Hong Kong.

A further community initiative with Lee Hysan Foundation involves HKUST and two local high schools working to design and fabricate 50 prototypes of novel high-intensity, narrow wavelength (HiNW) light-based disinfection robots for use in homes for the elderly and community NGOs.

"Being able to deploy the antimicrobial technology to assist both local endeavors and communities beyond Hong Kong to safeguard people's health means the years of research and testing have really been consequential," Prof. Yeung said. "It shows how thinking outside the box to define the essential attributes of such a technology combined with engineering can really make a difference."

## MAP-1 way to disinfection

Using a special blend of antimicrobial polymers, the MAP-1 coating effectively kills up to 99.99% of bacteria and viruses through contact killing and anti-adhesion technology. The technology involves the creation of surface moieties that actively disrupt the microbial envelope and biomolecules, rendering the microorganisms "non-viable" (inactive) on contact. The coating also prevents microbial adhesion on the surface, thus keeping it clean from microbial contaminants.

Prof. Yeung and his team have worked with the Hong Kong government's Water Supplies Department and the Drainage Services Department to field test MAP-1 in coating materials for water pipes and sewage drainages to prevent microbial contamination and infrastructure corrosion.

Earlier in 2020, Chiaphua Industries Ltd. donated up to HK$1.5 million worth of antimicrobial air filters – air-purification technology developed by Prof. Yeung's team in 2017 – to various hospitals in Mainland China, including Wuhan's emergency Huoshenshan Hospital.

# Fever screening system safeguards public health

As the COVID-19 crisis started to unfold, Prof. Richard SO, Industrial Engineering and Decision Analytics, immediately drew together a multidisciplinary team to devise technology to help prevent its spread in Hong Kong.

Prof. So, whose research interests lie in bioinspired signal processing and auditory and visual perception, and his School of Engineering co-researchers, with expertise in machine learning, bioengineering, and parallel networking, came up with a solution in just six days. They devised a novel screening system to identify people with a fever, a significant symptom of COVID-19 and other infectious diseases, especially those moving within larger groups of travelers or passers-by.

With the support of the Hong Kong government's Electrical and Mechanical Services Department, in January 2020, 16 of the team's Smart Fever Screening Systems were delivered for deployment at major border points, such as Hong Kong International Airport and Lo Wu, and later used in government facilities. The screening system was also introduced at the HKUST campus.

While thermal imaging detectors have been widely used at border points for screening inbound travelers since the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak hit Hong Kong, control point officers have had to monitor two screens with separate thermal and color CCTV images

The system (left screen) has been deployed at Hong Kong border control points and government facilities.


The Smart Fever Screening System can accurately detect a person's temperature even when their face is partly hidden.

to detect a sick person, all within the few seconds it takes for them to walk by.

Using artificial intelligence, real-time tracking, and decision analytics, the HKUST system more efficiently combines these two sets of images on to the same screen, with an unwell person bracketed in red and an alert triggered on detection. The new system is built on research for a completed big data platform for smart transportation, supported by the Innovation and Technology Fund and Thales Group in 2017, Prof. So said.

Through deep learning and the science of anthropometry, the fever screening system can track a face, even if three-quarters concealed. Temperature detection is more accurate as it relies on computer algorithms instead of human judgement. The system also has the capability to screen 50 to 100 people at the same time from a distance of up to 10 meters.

As the tracking focuses on the face, detection results are unlikely to be affected by any heat-emitting objects that a person is carrying. In addition, the system can learn over time to become smarter and even more accurate.

Researchers involved in creating the technology include Prof. Bertram SHI and Prof. Albert WONG, both Electronic and Computer Engineering, and Prof. CHEN Qifeng, Computer Science and Engineering.

Other potential locations for using the system include hospitals, schools, elderly homes, and libraries.

# Green light for self-driving delivery vehicles during lockdowns

Autonomous vehicles designed by Prof. LIU Ming, Electronic and Computer Engineering and Director of the Intelligent Autonomous Driving Center at HKUST, took to the road on a crucial mission in different areas of Mainland China during the COVID-19 crisis by delivering food to residents in locked-down locations.

Prof. Liu, who is also the founder of start-up Shenzhen Unity Drive Innovation Technology (UDI), provided several driverless vehicles to the cities of Zibo in Shandong province, Suzhou, and Shenzhen, to boost virus containment measures.

UDI initially donated two low-speed unmanned vehicles to Zibo, where Prof. Liu was born. The vehicles, termed "running robots" by Prof. Liu, created a contactless alternative to regular deliveries, reducing the risk of person-to-person infection. Starting in February 2020, they transported fruit, vegetables, and other supplies to severely affected areas, driving themselves with the help of multiple sensors, including cameras and lidars (employing laser-ranging sensors to measure distances).

The driverless vans carried about 750kg of supplies in the cargo compartment and were set to travel at between 15km and 25km (they can now reach 40km) per hour, enabling each van to make deliveries four times a day. Goods were first loaded on to the vehicle, then the destinations selected via a mobile app.

Later, the company also provided free unmanned vehicles to Pingshan district in Shenzhen. The vans distributed meals to a quarantined village, delivered materials to Shenzhen hospitals, sprayed disinfectant on streets, and broadcast messages to the community.

Prof. Liu Ming and his first autonomous vehicle at HKUST campus.


Making deliveries to help locked-down communities.

"When news of the coronavirus broke, we were confident that autonomous vehicles could play a positive role," Prof. Liu said.

Since joining HKUST in 2013, Prof. Liu's research has focused on the deployment of deep learning and deep reinforcement learning in mobile robotics, such as drones, unmanned vehicles, or boats. His research groups were among the first in the world to implement deep reinforcement learning on actual robots.

Prof. Liu's company was founded in 2018 to provide intelligent products for robotics, autonomous systems, smart logistics and transportation, among others. The crisis proved an unexpected and invaluable learning opportunity. "We gained priceless first-hand operating data and real-world experience," he said.

Extensive media coverage also raised public awareness of the benefits of autonomous vehicles and the many ways they could be useful.

UDI is now in discussion on solutions for several well-known companies. It has more than 100 employees in Shenzhen and a production base for both manned and unmanned vehicles in Shandong, supported by a near 1 billion RMB investment from the local government. UDI has established the world's first mass-production line specialized in autonomous vehicles there, along with an additional 30,000-square-meter test site. On May 21, UDI launched a new program for city-scale autonomous vehicle applications in Zibo.

Prior to the COVID-19 crisis, Prof. Liu's vehicles had been tested on the industrial campuses of Foxconn, the world's largest electronics contract manufacturer, telecommunications giant Huawei, and logistics firm SF Express.

View a video of Prof. Liu Ming's self-driving delivery vehicle at work, plus technical drawings in *IEEE Spectrum*

See the Zibo autonomous vehicle program launch

# Quarantine tracking seeks to mitigate outbreak

In order to enforce Hong Kong's home quarantine order, simply using a GPS signal is not effective because such a signal is often weakened or blocked by the city's numerous high-rises. Many buildings are also connected directly to shopping malls, without any significant GPS detection, creating a loophole for confinees to leave their designated areas.

However, Prof. Gary CHAN, Computer Science and Engineering, had just the answer: a cutting-edge geo-fencing technology which detects whether a confinee is inside or outside a predefined area by fusing, understanding, and learning various existing signals in the area.

Prof. Chan has conducted research and development on fusion-based signal learning technologies for many years. One application is indoor positioning, with his research team devising and deploying, via his company Compathnion Technology Ltd., a smart location finder to assist visitors in shopping malls or hospitals navigate their way around. He now saw how the signal fusion concept could be further developed, adapted, and applied as a user-friendly, efficient, and cost-effective way for quarantine monitoring.

Prof. Chan's team of researchers and engineers got to work, coming up with an automated geo-fencing technology they called "Signature Home". Geo-fencing involves setting up a virtual perimeter for a physical area. The idea was then deployed by Compathnion as a mobile app called StayHomeSafe. Paired with an electronic Bluetooth wristband worn by the person quarantined, the app could detect whether the quarantine order was being complied with, and alert the authorities if not.

The Signature Home technology is based on the concept that the collective signal values within a certain area are unique to that place, forming its "signature". It works as follows:

- The technology collects the various signals in a specific home environment – Wi-Fi, Bluetooth, cellular, for example – and uses them as the home's signature.


Prof. Gary Chan's mobile app, paired with an electronic Bluetooth wristband, was adopted by the Hong Kong government for quarantine tracking of inbound air travelers from March 2020.

- If the collected signal values at a certain time deviate from the signature, it is likely the person has left the designated area.
- By using machine learning and data analytics techniques, the technology can also intelligently adapt to the evolving home environment to achieve accurate monitoring.

Following the March 2020 introduction of a 14-day mandatory quarantine period for Hong Kong people or visitors coming into the city, the Hong Kong government adopted the StayHomeSafe app for enforcement purposes.

Such geo-fencing technology also achieves high user privacy because the system does not track nor know a user's exact position, according to Prof. Chan. It only detects whether a person is inside or outside his/her home. To further enhance location privacy, the system can be designed to only inform the authorities when the person is detected outside their designated area.

Mr. Arthur CHAN (2001 BEng in Computer Science), Director and CEO of Compathnion, added that the geo-fencing technology meant the app "can more effectively safeguard public health".

# The preventative role of mask-wearing

As COVID-19 lockdowns began to ease in many countries and regions in spring 2020, an international interdisciplinary team co-convened by Prof. De Kai, Computer Science and Engineering, released a timely study with significant implications for decision-makers and the general public globally on the importance of adopting mask-wearing as a preventative measure.

The collaborative team found that universal mask-wearing does play a major role in suppressing the spread or a second wave of the virus.

Simulation results indicated if 80% to 90% of the public adopted masking on about day 50 after an outbreak, before lockdown measures were lifted, the number of new COVID-19 infections could be slowed significantly. This in turn would help to avoid a second wave of cases. However, if only half the population wore masks or there was a delay (for example, to day 75), then significant slowing of the virus spread became unlikely.

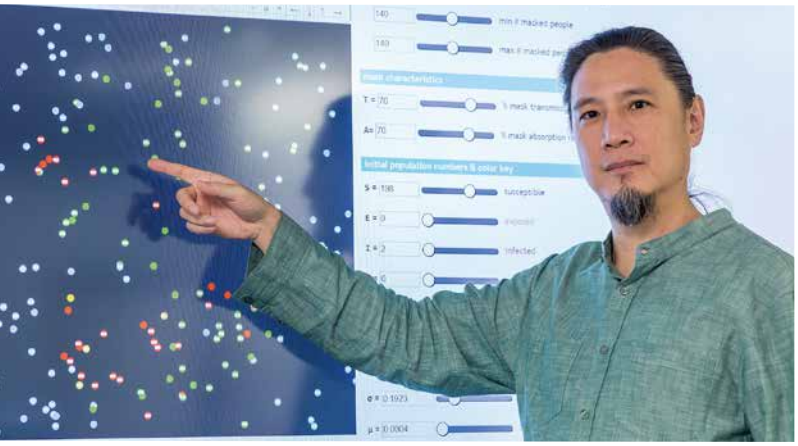
Along with Prof. De Kai, an artificial intelligence expert, the researchers comprised an economist, computational molecular biologist, medical doctor/PhD, and behavioral scientist from France, Estonia, the UK, and Finland.

The team produced two theoretical models to predict the impact of mask-wearing over time. The first extended the standard epidemiological SEIR model* to forecast the effects of mass mask-wearing. The second introduced an AI-inspired agent-based model, which simulates infections occurring from contact between individuals in physical space.

When mask effectiveness was also taken into account, the effects were the same, even with inexpensive non-medical or homemade masks with only 70% effectiveness.

Modeling results were validated and compared against empirical data from regions that at that time had best managed COVID-19 outbreaks, such as Hong Kong and

Prof. De Kai demonstrates the interactive visualization of the simulation.




Prof. De Kai and his multidisciplinary team's simulation results on universal mask-wearing have significant implications for policy decision-makers and the public globally.

Taiwan, where wearing masks in public was culturally acceptable or government policies advised people to do so.

This comparison showed a near perfect correlation between early universal masking and successful suppression of COVID-19 case growth rates and/or the rates of reduction from peak daily case growth. In contrast, areas that did not implement such measures have needed to maintain a strict societal lockdown.

"Locking down our noses and mouths is far preferable to locking down our full bodies inside our homes," Prof. De Kai said. "The cost of masks, including educating populations how to properly make and wear masks, is negligible in comparison to the large economic and human costs of increased infection rates."

The study, "Universal Masking Is Urgent in the COVID-19 Pandemic: SEIR and Agent-based Models, Empirical Validation, Policy Recommendations" was published as an e-print on arXiv, a leading open-access online archive, in April 2020.

Its findings were subsequently incorporated into a white paper by the team entitled "Universal Masking to Restart Society and Save Lives". The research has also been extensively reported online and in the mass media worldwide, including *Forbes* and *Vanity Fair*, as well as locally.

* A model in which the population is grouped into S for susceptible, E for exposed, I for infectious, and R for recovered or deceased.

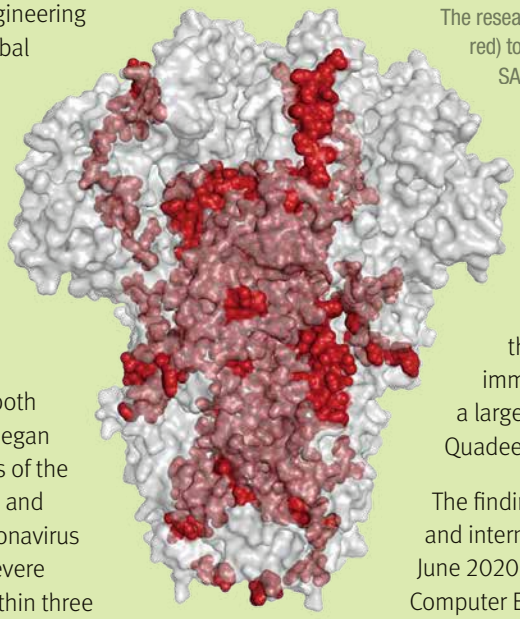
## Find out more

- Visit *http://dek.ai/masks4all* to explore all the universal masking project's public resources, including articles, videos, and online interactive simulator
- Watch Prof. De Kai explain his mask-wearing research further on *http://dek.ai/maskvideo*

# Identifying potential vaccine antigens

Data scientists at the School of Engineering were early contributors to the global search to find vaccine targets for COVID-19, the disease caused by the SARS-CoV-2 coronavirus. More recently, they have launched a web-based platform related to their initial findings to assist vaccine design.

In mid-January 2020, a team led by Prof. Matthew MCKAY and research associate Dr. Ahmed Abdul QUADEER, both Electronic and Computer Engineering, began analyzing the limited genetic sequences of the novel SARS-CoV-2 available at that time and experimental data of SARS-CoV, the coronavirus responsible for the 2003 outbreak of Severe Acute Respiratory Syndrome (SARS). Within three weeks, they had found genetic similarities in the two viruses that could aid identification of potential vaccine targets for SARS-CoV-2.



SARS-CoV spike protein

The researchers found 20% of SARS-CoV epitopes (in red) to be an identical genetic match with SARS-CoV-2.

The researchers discovered that a set of B cell and T cell epitopes derived from SARS – protein fragments that can trigger an immune response to SARS-CoV – also existed in the new coronavirus. “Among the SARS epitopes that can trigger the immune system, we found that 20% of them also existed in SARS-CoV-2, with their genetic sequences being exactly the same,” Prof. McKay said. “This made them highly likely candidates as antigens, or immune response triggers, for vaccines.”

For the T cell epitopes, the researchers also performed a population coverage analysis and found one set of epitopes was capable of inducing an immune response in a large portion of the population during the SARS outbreak. “Given this set of epitopes is genetically identical in the COVID-19 virus, it has the potential to elicit a protective immune response against SARS-CoV-2 in a large fraction of the global population,” Dr. Quadeer said.

The findings received extensive local, national, and international news coverage. By the end of June 2020, the article by Electronic and Computer Engineering PhD student Syed Faraz AHMED, Dr. Quadeer, and Prof. McKay had been cited over 200 times and received over 52,000 views. Their research appeared as the March 2020 cover article of the international scientific journal, *Viruses*, and was mentioned in a *New Scientist* cover story the same month.

In June 2020, the same team reported its development of COVIDep*, a first-of-its-kind web-based platform that provides real-time reporting of immune target recommendations for guiding SARS-CoV-2 vaccine development.

COVIDep implements a protocol that pools together publicly available genetic data for SARS-CoV-2 and epitope data for SARS-CoV to identify B cell and T cell epitopes that present potential immune targets for SARS-CoV-2. COVIDep is updated daily based on the latest SARS-CoV-2 sequence data. This is important as SARS-CoV-2 sequences are being made available at a rapid pace, and the recommendation of vaccine targets is influenced by newly observed genetic variation in SARS-CoV-2. An article describing COVIDep was published in *Nature Protocols*.

* https://COVIDep.ust.hk

From right: Prof. Matthew McKay, research associate Dr. Ahmed Abdul Quadeer, and Hong Kong PhD Fellowship Scheme student Syed Faraz Ahmed.

# Mining scientific data and debunking myths

An Electronic and Computer Engineering team of postgraduates and software engineers, led by Prof. Pascale FUNG, Director of HKUST's Center for Artificial Intelligence Research (CAiRE), has successfully responded to a recent call to the world's AI experts to help the medical research community during the pandemic.

Competing against more than 1,000 teams globally, the School of Engineering team led by PhD student SU Dan (see P25) won one of the 10 tasks set in the recent Kaggle COVID-19 Open Research Dataset Challenge (CORD-19 Challenge), by building a leading machine learning-based system with top natural language processing question-answering techniques, combined with summarization, for mining scientific literature on COVID-19. They have also successfully used their system for debunking virus myths, based on scientific evidence.


Natural language processing expert Prof. Pascale Fung is seeking to unlock the power of machine learning for medical research.

Kaggle is the world's largest data science community and a subsidiary of Google.

With an end-to-end neural network-based open-domain question-answering system, the CAiRE-COVID system can quickly generate ranked lists and paragraph-level summaries from CORD-19's tens of thousands of scholarly articles. The dataset was created by the Allen Institute for AI in partnership with the Chan Zuckerberg Initiative, Georgetown University's Center for Security and Emerging Technology, Microsoft Research, and the National Library of Medicine - National Institutes of Health, in coordination with the White House Office of Science and Technology Policy.

"CAiRE-COVID aims to facilitate the medical community, in the time-critical race to find answers to various COVID-related queries in the hope of finding a cure for the virus," said Prof. Fung, a 30-year expert in the challenging area of natural language processing research.

The CORD-19 Challenge was important, Prof. Fung said, as it was the first open-search and open-call initiative using AI in the medical field. "With this collaboration, we hope that the power of machine learning in medical research will be unlocked," she said.

Working together with PhD student LEE Nayeon and MPhil student BANG Ye Jin, Prof. Fung has also found a way to flag misinformation by measuring how "predictable" the subject is in a statement, based on the scientific evidence provided by the question-answering engine designed for the Kaggle contest and CORD-19 dataset. By June 2020, the dataset had increased to over 158,000 articles.

The HKUST team has publicly released the source code of both their question-answering system and myth debunker so that other developers can use it for further work.

Meanwhile, Prof. Fung and her researchers are now collaborating with Dr. Oliver MORGAN, Director of the Health Emergency Information and Risk Assessment Department at the World Health Organization (WHO), on WHO's Epidemic Intelligence from Open Sources initiative to co-develop question-answering and summarization technology. The goal is to find answers from millions of online materials for early detection, verification, and assessment of public health risks.

# Teaching and learning in the time of COVID-19

As the COVID-19 outbreak and strategic measures to deal with it ratcheted up in Hong Kong in early 2020, the start of the Spring semester was delayed at HKUST, assisting decisions to move to total interactive online learning and faculty to prepare for this switch.

Although the School of Engineering (SENG) has played a significant role in the introduction of blended learning (a mix of face-to-face and digital/online instruction) and online learning via Massive Open Online Courses (MOOCs) at HKUST and globally over the past decade, full interactive online teaching was a new experience for most instructors and students.

The form adopted by HKUST was to use Zoom to deliver all classes on schedule, and in person, meaning teachers gave and learners took the courses virtually in real time.

To master such teaching, the University set up many tutorials for faculty on using and optimizing the software and other equipment. For example, academics were shown how to create their own whiteboards using a piece of paper and a well-positioned camera. In addition, multi-camera set-ups were employed, for instance, one directed on the "whiteboard", another on a PowerPoint, while a third could capture the instructor's face.

Difficulties related to online examinations and assessment were also addressed, with training arranged for instructors in handling fairness, monitoring, and other such issues.

Initially, students pushed back against full online teaching, especially in the early stages of the pandemic when fewer locations were affected. However, surveyed after two weeks, and again at mid-term, more than 60% of SENG students reported they were satisfied, feedback similar to classes where they are physically present.

"We have had instructors who reported they found students more comfortable about asking questions, as with online tools this meant questions could also be typed," Dean of Engineering Prof. Tim CHENG Kwang-Ting said.

Meanwhile, laboratories that were essential for thesis research for some engineering students, particularly those focusing on chemical, mechanical or electronic engineering, were partially re-opened during the semester. With the School working together with the University's Health, Safety and Environment Office, lab access entailed adherence to stringent protocols, including wearing of masks, temperature checks, logging of start and finish times, and careful scheduling of sessions.

"Our attitude throughout has been one of caution, with safety the top priority, ahead of everything else," Dean Cheng said.

School arrangements have been overseen by the Dean and his management team, comprising Associate Deans, Department Heads, and Administration Unit Heads. Members have met regularly to discuss critical issues, policies, and actions, including taking care of the many challenges facing both undergraduate and postgraduate students. HKUST senior management have handled University-wide issues.

"Moving forward we are still very cautious," Dean Cheng said. "The types of challenges we have had to handle are unique for academics, situations we have never had to deal with before. But it shows HKUST's robustness to take proper action in a time of crisis.

"Actually, every crisis offers new opportunities as it causes us to reflect and we change our mindset," he pointed out. "We have tried hard in the past 10 years to do blended

Multiple cameras have helped faculty deliver effective real-time interactive online teaching.

Instructors have found some students are more comfortable asking questions online.

learning, for example. Now, if people see the value of online interactive lecture delivery, then you will fundamentally change engineering teaching in a classroom setting."

Dean Cheng is also expecting that this experience will serve as a living example of the need for engineering education to move beyond the training of technical experts toward the provision of solutions and services that can impact society. "From this pandemic, we have seen our faculty and alumni produce so many useful solutions, provide something needed," he said. "That's why we must strengthen our students' training in the humanities in addition to technical knowledge. In this way, they will understand people's needs, and the services and products they create will not just be another technical solution or gadget but impactful and relevant."

# Turning virtual assignments into real-life impact

By Prof. Pedro Sander, Computer Science and Engineering

In Spring semester 2020, I co-taught an introductory C++ programming course for undergraduates with Dr. Cecia CHAN and Dr. Cindy LI. As with other HKUST courses, we had to conduct our classes entirely on Zoom. The virtual setting made it more challenging to interact with students during lectures, though after-lecture Zoom discussions were productive and the interaction very natural. We did have to overcome some challenges on organizing the programming lab sessions and exams, but in terms of teaching the material, I feel Computer Science in general is suitable for this setting.

To show how work as a computer scientist relates and can potentially impact topical aspects of life, in this case COVID-19, we decided to explore the wealth of data available to enable students to analyze the current outbreak in different countries.

The Center for Systems Science and Engineering at Johns Hopkins University in the US keeps daily updated statistics for COVID-19 cases. We used this data as input, and worked with teaching associate Mr. Wallace MAK to develop an assignment asking students to process the data and generate relevant statistics about the outbreak.

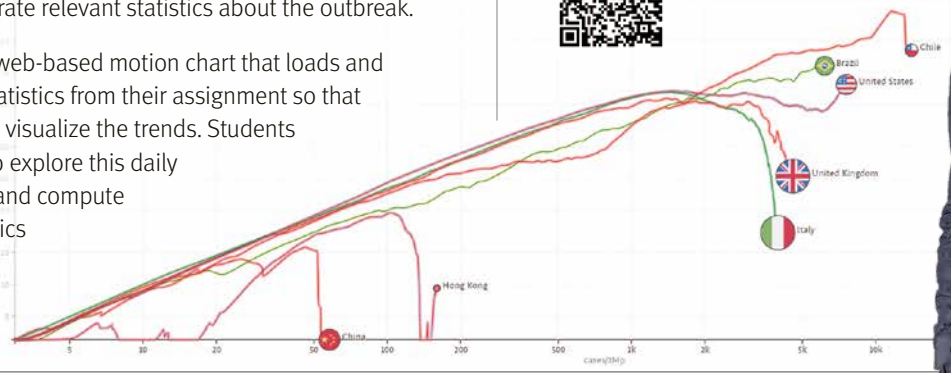
I developed a web-based motion chart that loads and displays the statistics from their assignment so that students could visualize the trends. Students were excited to explore this daily updated data and compute relevant statistics that allowed them to clearly understand the current situation in different countries.

Meanwhile, I continued to work on a more advanced version of the visualization tool online. It became a hit, with several people using it daily to explore the statistics and better analyze the current situation in several countries.

This work also sparked research on how to assign optimal colors to countries in the visualization. I am now collaborating with Prof. Guilherme FONSECA, from Aix-Marseille University in France, who is developing and fine-tuning an algorithm to assign automatic color visualizations based on national colors. We plan to further explore other aspects of the visualization.

So from one innovative project assignment to multiple impacts, not only on students but on the wider community as well.

View the COVID-19 statistical web-based motion chart




# Student awards & achievements

Bioengineering PhD student **PARK Byung Min** (2015 BSc in Biology) has received a Fulbright-Lee Hysan Visiting Student Scholar 2020-21 award to study at the California Institute of Technology. His thesis research explores the potential of engineered proteins as bioimaging contrasts through the development of bioacoustic and photoacoustic tools and materials for safe, precise detection of various cancers.

Division of Integrative Systems and Design undergraduate **Mashiat LAMISA** received an Empower Women Through Technology Prize at Vancouver's all-female "cmd-f" 24-hour hackathon, while on exchange at the University of British Columbia (UBC). Together with two other UBC students, Mashiat created the Know Your Rights app to help women and other gender minorities get to know their workplace rights, including gender wage gaps and harassment. The event attracted 70 teams and a total of 278 participants.

Dr. **ZHU Shangqian** (third left) (2020 PhD in Chemical and Biomolecular Engineering) received the School of Engineering PhD Research Excellence Award 2019-20 for his research focused on electrochemical energy conversion and storage technologies that seek to address global climate change and energy depletion issues. His work had resulted in 13 publications in top journals and over 600 citations by June 2020. He is now a Research Grants Council postdoctoral fellow at HKUST.


Four 2019 BEng graduates from the Department of Chemical and Biological Engineering won the Hong Kong Institution of Engineers (HKIE) Environmental Division Prize for Best Final Year Environmental Project 2018-19. The team comprised **FUNG Hiu-Tung** (fourth left), **LAU Siu-Mei** (third left), **LEUNG Ho-Fung** (not pictured), and **WONG Hon-Fai** (second right). The students' project looked at developing a combinative adsorption and photocatalytic unit for remediation of electroplating effluents.

A cross-disciplinary team received the Outstanding Students Award at the Autodesk Hong Kong Building Information Modeling (BIM) Awards 2019. Their project investigated the integration of BIM and the internet of things for smart facility management at HKUST campus. Team members comprised Civil and Environmental Engineering PhD student **Helen KWOK Hoi-Ling** (not pictured) and 2019 PhD graduate **CHEN Weiwei** (third right), together with 2019 Dual Degree Program in Technology and Management graduates **CHAN Sum-Chau** (third left) and **Sampriti DWIVEDY** (second left).

# PhD problem-solver who finds her own way

As a female engineer, PhD student SU Dan (Class of 2022, Electronic and Computer Engineering) has frequently had to forge her own path in relation to both her family and society's expectations. However, the down-to-earth high achiever has persisted and shown her capabilities and self-motivation in settings ranging from the workplace and entrepreneurial world to academic team leadership.

"Individual thoughts were something I have had since a young age. I didn't really set long-term goals," Dan said. "I always try to do things well and solve problems on the way." In doing so, she said, opportunities came along "and I grasped them".


Competitive edge: Su Dan led separate HKUST teams to success in two high-profile contests in her first 12 months as a PhD student.

From her earliest years, Dan excelled academically, starting school in Shaanxi province in Mainland China a year early but still coming top of her class and winning awards in national mathematics competitions.

Following her Computer Engineering program at the University of Science and Technology of China, where she basically had to start from scratch due to little prior exposure to computers, she gained a scholarship to join the School of Engineering (SENG)'s MPhil in Electronic and Computer Engineering in 2009. She went on to publish three papers and participate in conferences overseas, all notable achievements for an MPhil student, as well as head the HKUST Mainland Students and Scholars Society.

After graduating in 2012, Dan went on to join a bank, co-found a robotics company, and then work for SF Technology, an affiliate of delivery giant SF Express. As the Senior Machine Learning and AI Engineer at SF, she was tasked with building a system to retrieve lost claims, a tough task that she solved through substantial research of her own in order to build machine learning algorithms.

The conceptual model she produced became the solution, earning her several patents and adaptations of which are still being used by the company today.

Despite her success there, Dan wanted to deepen her research knowledge further and in 2019 re-entered SENG to pursue a PhD. Just two weeks later, she led a team of PhD students and engineers from EMOS Technologies to the first prize in the Chatbot Millionaire Challenge, organized by Hong Kong Science and Technology Parks Corporation.

Recently, she also steered a HKUST Center for Artificial Intelligence Research (CAiRE) team in the Kaggle COVID-19 Open Research Dataset Challenge (see P21). HKUST gained the highest score among over 1,000 global teams in one of 10 set tasks.

The University participants built their own machine learning-based system that rapidly generates ranked lists and paragraph-level summaries of over 57,000 scholarly articles about COVID-19 and related coronaviruses to facilitate the medical community in finding answers to queries.

*cont. P26* ►

# Global recognition

Alumni Dr. ZHANG Xiaowu (1999 PhD in Mechanical Engineering) and Prof. Angela ZHANG Yingjun (2004 PhD in Electrical and Electronic Engineering) have been elected 2020 Institute of Electrical and Electronics Engineers (IEEE) Fellows, the highest grade of membership in the prestigious worldwide professional association.

Xiaowu was accorded the recognition for his contributions to three-dimensional integrated circuits. He is a senior scientist and principal investigator for the Interconnection & Packaging Program, Institute of Microelectronics, at the Agency for Science, Technology and Research (A*STAR). A*STAR is Singapore's major public agency for spurring scientific discovery and innovative technologies. Yingjun, now an associate professor at the Chinese University of Hong Kong, received the accolade for her contributions to resource allocation and optimization in wireless communications.

IEEE membership stands at more than 419,000 globally, covering more than 160 countries. Each year, fellowship recipients do not exceed 0.1% of the total voting IEEE membership.

# In memoriam

The School of Engineering is deeply saddened to report that Michael NG Kwok-Hing (2016 BEng in Civil Engineering) has died following a traffic accident in Hong Kong on April 9, 2020. Michael was employed as an assistant engineer at Wong & Cheng Consulting Engineers Ltd., a civil, structural, and geotechnical engineering consultancy. A keen sportsman at HKUST, he was a former member of the University's distance running and rowing teams. Michael had maintained close ties with HKUST since graduation, attending many alumni events and continuing to represent the University in sporting activities as an alumnus. He will be greatly missed.


◄ *cont. from P25*

In addition to her self-initiative and drive, being an optimist has always kept Dan moving forward. "There might be painful experiences that drove me to tears, but the next morning I forgot about them and started anew. Hurdles are only meant to be inspirational," she said.

As an example, while her parents in Shaanxi were concerned that going back to study might make it difficult to keep up her mortgage repayments on her flat in Shenzhen, she herself felt confident to try. "I might be slightly older than other PhD students, but I have learned to solve problems. Other people may feel the pressure, but I like finding solutions."

Su Dan with her winning team at the Chatbot Millionaire Challenge in Hong Kong.

# Platform pairs research with industry needs

A transformative knowledge transfer platform to assist local industry technology upgrades through deployment of research innovations from HKUST, and other institutions, has been set up by PhD alumnus Dr. TSUI Kwong-Hoi (2019 PhD in Electronic and Computer Engineering, 2013 BSc in Chemistry).

The goal of the platform is to work with manufacturers to understand their needs and improve production processes and current practices. This provides an alternative to the usual "top-down approach", whereby university teams devise new technologies on their own and then try to launch them on the market.

The initiative involves an enterprising collaboration with the Chinese Manufacturers' Association of Hong Kong (CMA).

The pairing platform enables the CMA to use its many connections with local industries to discover issues facing companies. It then refers them to Dr. Tsui's company, Sundial Technology Development Ltd., to locate relevant institutional technical solutions.

To assist the food packaging industry's competitive edge, for example, Dr. Tsui brought together one company and nano-antibacterial film technology from the research team of his former supervisor Prof. FAN Zhiyong, Electronic and Computer Engineering (see P10-11).

With a small modification, the technology was set to work, helping the firm extend its reach from general food packaging to the high-end food market.

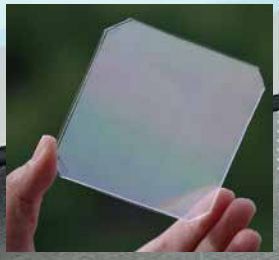
"Although we only set up the platform at the end of 2019, by January 2020, we had already received over 20 approaches, including four listed companies," Dr. Tsui said. "This shows both the demand for and value of such a matching service."

Another food industry innovation hailing from Prof. Fan's team contributed to the new platform through specially designed gas sensor odor detectors. Such detectors can help local food processing plants strengthen quality control, leading to savings on labor and boosting efficiency.

Dr. LO Kam-Wing, Vice President of the CMA, noted traditional industries constantly needed to evolve to stay competitive. While they often had the resources, they did not have the links to researchers creating novel technologies. Universities, on the other hand, may lack practical know-how on applying their new concepts in an industrial setting or scaling them up for mass production.

As such, the platform serves a valuable bridging role in bringing the different parties together, spurring innovation that benefits both the economy and society.

Dr. Tsui established Sundial Technology in 2016 while still a PhD student at HKUST. The same year, he and his teammates joined the University's sixth annual One Million Dollar Entrepreneurship Competition, winning the top President Award as well as the Innovation and Student Awards for their innovative anti-reflection and self-cleaning film for solar panels. The project was initially overseen by Prof. Fan.



HKUST's odor detector (top) and nano-antibacterial film technologies.




Collaborative spirit: group picture, alumnus Dr. Tsui Kwong-Hoi (left), Vice President of the Chinese Manufacturers' Association of Hong Kong Dr. Lo Kam-Wing (center), and Prof. Fan Zhiyong (right).

# Going places

Members of the first cohort of Hong Kong Diploma of Secondary Education holders to graduate from the Department of Computer Science and Engineering in 2016 are making their mark in careers across the world

## Different directions, similar outlooks

All three graduates demonstrated a range of valuable personal qualities in their careers, following their School of Engineering undergraduate experience:

- A desire to explore new horizons
- Determination to overcome challenges
- An aspiration to keep improving
- Willingness to leave their comfort zone
- Adaptability to different work environments
- Well-defined goals

Japan

## E-commerce in Tokyo

CHAU Wing-In has always been fascinated by Japan and was determined to visit the country after learning in Year 1 at HKUST that the University offered many overseas student exchange opportunities. “When I finally went to Sophia University in Tokyo, I enjoyed life there very much,” she said.

After returning to HKUST to finish her degree, she later secured a job at Rakuten, Inc., a leading Japanese e-commerce and online retailer, through Career Mosaic, the University’s biannual recruitment fair. In 2016, she moved to Tokyo as a Rakuten producer, handling project management, big data analysis, and modeling to enhance departmental performance.

Although Wing had few problems settling in with her multinational teammates, she initially found it puzzling that in meetings, Japanese colleagues would never openly disagree with others. “After the meeting, however, one by one they might come to me and share different views.” This, she now attributes to the Japanese approach to cross-cultural communication, and has adapted to it.

Wing also still has one goal to fulfill, she said. To be able to speak Japanese like a native speaker!


Chau Wing-In believes the project management and communication skills she gained through her Final Year Project were key factors in securing a job as a Rakuten producer and her new life in Japan.

Germany

## Relaxing into European life as a digital games developer

Stephen LUI Ka-Fai's longtime aspiration was to explore life in Germany. Following his graduation, he bravely flew to the city of Hamburg in 2017 without a job. However, it only took four months to rectify that. "My engineering background was a great help," he said.

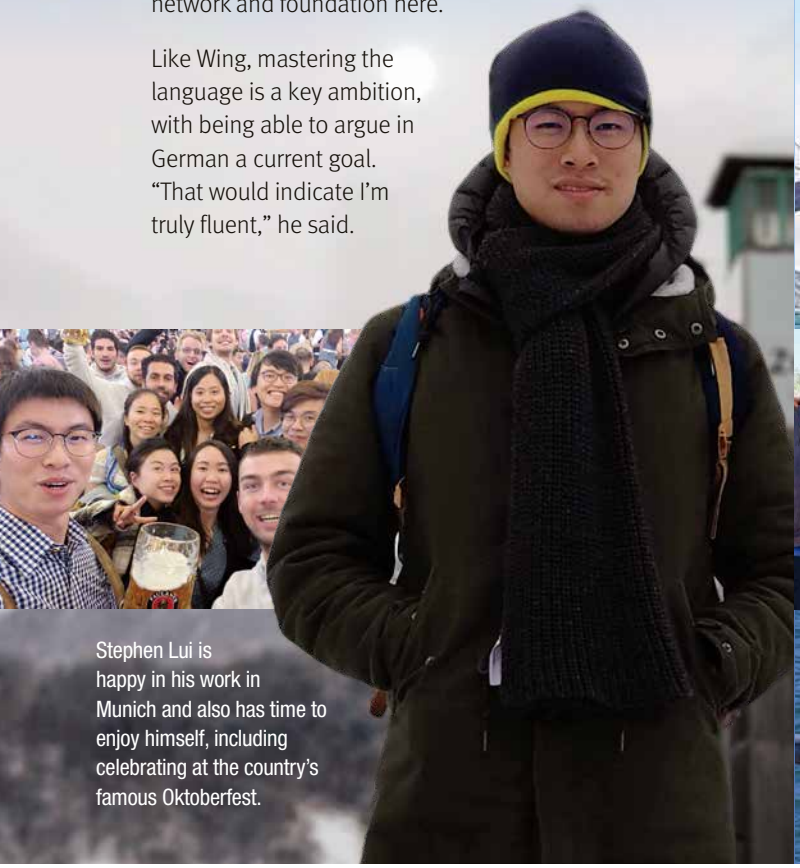
He is now enjoying life in Munich. Initially, he worked for Koch Media, a major producer and marketer of digital entertainment products. There, he developed telemetry tools that collected analytic data on game-playing behavior to assist the marketing and development teams build and sell new products.

He also had to learn to cope with a different style of working. "My colleagues, who are mainly German or from other European countries, were friendly. It just took me some time to get used to their more relaxed attitude to deadlines."

More recently, Stephen moved to Realmforge Studios, also in Munich, where he is engaged in actual game development.

It wasn't always straightforward to be in a different land, and he was grateful to a fellow Computer Science and Engineering alumnus in Hamburg, who gave him many tips, including how to tailor his resume and cover letter. "I had zero network and foundation here."

Like Wing, mastering the language is a key ambition, with being able to argue in German a current goal. "That would indicate I'm truly fluent," he said.



Stephen Lui is happy in his work in Munich and also has time to enjoy himself, including celebrating at the country's famous Oktoberfest.

United States

## LinkedIn to the American dream

Alan SHUM Ka-Yi's dream destination was the United States. "I missed out on the chance to go there on exchange in Year 3, and went to South Korea instead. But, luckily, I was chosen for a summer internship at an American computer software company, so I flew to San Francisco right after my exchange program ended. When I graduated, the company offered me a job."

He later joined LinkedIn, the world-famous employment-oriented online business, as a software engineer, helping to build sales solutions at the company's global headquarters in Sunnyvale, California.

Alan found it a challenge to start from scratch. "Suddenly I had to handle everything myself in a city in which I knew nobody and nothing," he said. This he managed well, with assistance from his co-workers, and he now has a clear career path at LinkedIn: "I didn't struggle much at work and my teammates have always been helpful and willing to teach me," he said.

Alan Shum (center) with colleagues at start-up Compass, where he worked during his School of Engineering internship in San Francisco.

# Faculty awards & achievements

## External honors



Three academics in the Department of Civil and Environmental Engineering have been honored for their respective research in the 2019 Higher Education Outstanding Scientific Research Output Awards (Science and Technology) from the Ministry of Education. Research led by Chair Professor **Irene LO** (left) was accorded a Natural Science Award (Second Class) for studies on applying iron-based magnetic materials in heavy metal pollution control. Chair Professor **ZHANG Limin** (center) and his team received a Natural Science Award (First Class) for geotechnical research into rain-induced failure of colluvium soil slopes and risk mitigation measures. Prof. **Christopher LEUNG** (right) gained a Scientific and Technological Progress Award (Second Class) for research on optimizing the design of high ductility cementitious composites and infrastructural performance improvements, carried out in collaboration with Southeast University, Nanjing Forestry University, Nanjing Hydraulic Research Institute, and industry partners. The accolades are among China's top awards for science and technology.

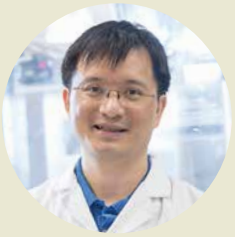
Prof. **Joseph LEE**, Senior Advisor to the President and Visiting Professor, Civil and Environmental Engineering, has been appointed Chairman of Hong Kong's Research Grants Council by the Hong Kong government, effective July 1, 2020. The term is for three years.

Chair Professor **YANG Qiang**, Computer Science and Engineering, has been elected general chair of the Association for the Advancement of Artificial Intelligence (AAAI)'s 35th conference, AAAI-21, which will be held in February 2021 in Vancouver. The gathering is a top international conference promoting artificial intelligence research and exchange among researchers, practitioners, scientists, and engineers.

Fang Professor of Engineering and Chair Professor **Kei May LAU**, Electronic and Computer Engineering, has received the 2020 Nick Holonyak Jr. Award from The Optical Society (OSA) for her contributions to semiconductor-based optical devices and materials. The OSA is the leading global professional society in optics and photonics, promoting and delivering scientific and technical information worldwide.


Chair Professor **ZHANG Tong** (left), Mathematics and Computer Science & Engineering, and Prof. **CHEN Lei** (right), Computer Science & Engineering, have been elected 2020 Fellows of the Institute of Electrical and Electronics Engineers (IEEE), bringing the number of IEEE Fellows among School of Engineering faculty to 41. Prof. Zhang was recognized for his contributions to machine learning algorithms and Prof. Chen for his research into time series management and spatial crowdsourcing.

Chair Professor **YANG Hai**, Civil and Environmental Engineering, has received the 2020 Frank M. Masters Transportation Engineering Award from the American Society of Civil Engineers for his outstanding leadership in research and mentoring in the fields of transportation network modeling and transportation economics. The award recognizes innovative or noteworthy planning, design, or construction of transportation facilities.



Prof. **LUO Zhengtang**, Chemical and Biological Engineering, has been made a Fellow of the Royal Society of Chemistry for his research on the chemistry of graphene and two-dimensional (2D) materials, and applications of 2D materials in fields such as biomedical engineering, energy storage and conversion, electronics, and optoelectronics.

Prof. **Tim WOO**, Electronic and Computer Engineering, has been elected Chairman of the Institution of Engineering and Technology (IET) Hong Kong for 2020. The Hong Kong branch has more than 5,000 members, one of the IET's largest local networks. The institution has over 168,000 members in 150 countries and regions.

Prof. **SHI Ling**, Electronic and Computer Engineering, was named a 2020 World Economic Forum Young Scientist. He was among 25 leading young researchers under 40 years of age selected from 14 countries and regions this year. The Young Scientists community was established in 2008 to involve rising research talents in the work of the World Economic Forum. He is the third School of Engineering academic to be accorded this accolade.

## HKUST

School of Engineering faculty received all three top honors in the University's 2019 Common Core Award. Prof. **Marshal LIU** (left), Chemical and Biological Engineering, received the Common Core Teaching Excellence Award for his innovative "Introduction to Food Science and Technology" course. Prof. **Kenneth LEUNG** (center) and Prof. **Raymond WONG** (right), both Computer Science and Engineering, received Honorary Mentions for their courses, "Exploring Multimedia and Internet Computing" and "Exploring and Visualizing Data" respectively.

# New appointments

## Administrative

**Prof. QU Huamin**
Appointed Director of Interdisciplinary Programs Office
Professor, joint position in Computer Science & Engineering and Electronic & Computer Engineering

**Prof. Charles NG**
Appointed Acting Dean of HKUST Fok Ying Tung Graduate School
Associate Vice-President for Research and Development
Chair Professor, Civil and Environmental Engineering

**Prof. Ricky LEE**
Appointed Executive Director of Shenzhen Platform Development Office
Chair Professor, Mechanical and Aerospace Engineering

## Faculty Member

**Prof. ZHOU Yanguang**
Assistant Professor, Mechanical and Aerospace Engineering
PhD – RWTH Aachen University

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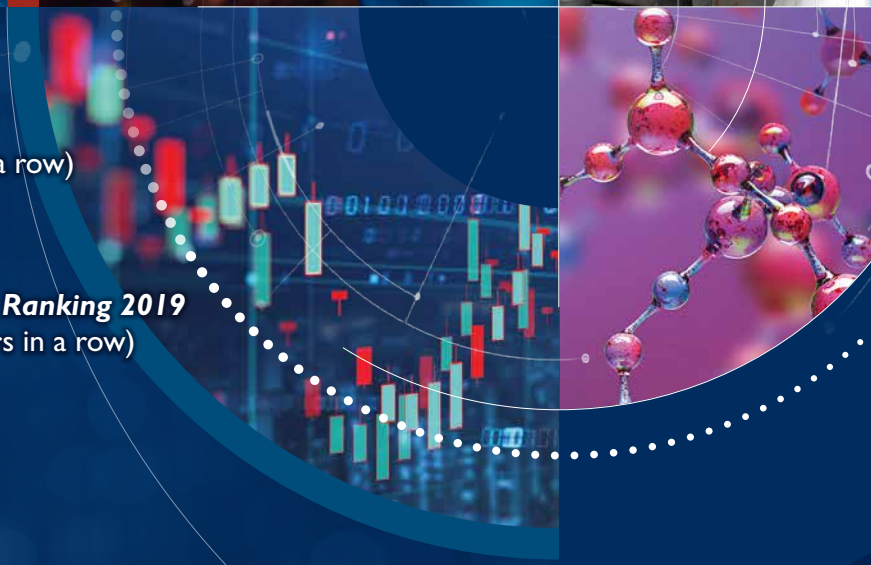
- IC Design Engineering
- Information Technology
- Intelligent Building Technology and Management
- Mechanical Engineering
- Technology Leadership and Entrepreneurship
- Telecommunications



HKUST

**#1** ***Young University Rankings 2020***
(No.1 in the world, three years in a row)
*– Times Higher Education*

**#10** ***Global University Employability Ranking 2019***
(No.1 in Greater China, seven years in a row)
*– Emerging/Trendence*

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