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Stepping Into the Metaverse

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

工學院
SCHOOL OF ENGINEERING

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At the forefront of change

Welcome to the latest issue of *In Focus* and my first column as Dean of the HKUST School of Engineering (SENG). As 2023 commences, we move forward into a new and exciting year where the COVID-19 pandemic may finally recede from centerstage and fresh horizons beckon. As a specialist in smart transportation, I see this as a propitious sign for the start of my own new journey as I take up the great honor and responsibilities of the deanship.

Since joining the then Department of Civil and Structural Engineering (now Civil and Environmental Engineering) in the mid-1990s, not long after HKUST was established in 1991, I have been fortunate to witness and contribute to SENG's rapid rise to global prominence through diverse roles in education, research, and administration at the University and my active participation in the academic world and wider community beyond the campus.

High global rankings are one indication of SENG's leading achievements. However, I believe the number one reason for the School's distinctive character is our community of hardworking, high-achieving, self-motivated faculty, students, staff, and alumni. It is their passion to work at the highest levels of engineering education, research, and the profession, along with a growing drive for knowledge transfer, entrepreneurship, and social impact, that creates such an inspiring environment across the many fields the School embraces.

Established and emerging research areas cover an extensive range: advanced materials; aging & healthcare; AI; autonomous systems & robotics; communications; data science; design thinking & entrepreneurship; energy & sustainability; microelectronics; and smart cities. On the education front, the School has helped advance massive open online courses (MOOCs) and continuously explores novel engineering pedagogies.

As Dean, I will be seeking to extend the School's reach by enhancing our capabilities and platforms to tackle large-scale and complex interdisciplinary projects. In particular, we will strive to address the grand challenges and sustainable development goals that must be solved worldwide to improve the lives of the generations to come – energy, climate change, health and well-being, industry, innovation, and infrastructure, to name but a few. In this quest, I see the complementary strength of colleagues at HKUST's cross-disciplinary-oriented Guangzhou campus, which opened in September 2022, and collaborative ventures with national and international partners as being highly productive to scaling up our capabilities.

Further priorities are to proactively recruit top faculty and students from around the world to sustain and advance SENG's dynamic environment; strengthen the School's connections with industry to build mutual understanding of research and technology transfer needs and challenges; and deepen engagement with alumni.

Engineers create and deliver the technologies that shape the world. At SENG, we strive to be at the forefront of such forward moves. With the Hong Kong government's focus on transforming the city into a global innovation and technology hub, and the Greater Bay Area development plan bringing a host of opportunities regionally, it is certainly a prime time to connect up and be part of the SENG community.

Prof. Hong K. LO
Dean of Engineering

HKUST pacesetters take office

It has been a time of change at the top of HKUST over recent months, bringing two outstanding University scholar-administrators and one new face – all with links to engineering – to three key leadership positions.

In October 2022, globally renowned molecular neuroscientist Prof. Nancy IP took the helm as HKUST's fifth President, becoming the first woman to head one of Hong Kong's University Grants Committee-supported universities. Prof. Ip, who has spent 30 years at HKUST, has played an integral role in instituting the excellence that has powered the University's rise to a world-leading institution just three decades after its establishment in 1991. She is an elected member of the Chinese Academy of Sciences and an international member of the US National Academy of Sciences, among many other eminent recognitions and awards.

President Prof. Nancy Ip

Born and raised in Hong Kong, Prof. Ip received her PhD in Pharmacology from Harvard University under the tutelage of Prof. Richard ZIGMOND, and later developed a successful career in industry, before joining HKUST in 1993. A highly accomplished researcher, she has made seminal contributions toward the development of diagnostic and prognostic tools for Alzheimer's disease. She also actively collaborates with renowned researchers from around the world and is passionate about nurturing local talent. Her cross-disciplinary collaborations have led to important breakthroughs, such as the development of imaging technology with faculty at the School of Engineering (SENG), which has shed light on the functions of brain regions that were previously hard to explore.

Provost Prof. Guo Yike

At the start of December, distinguished computer scientist Prof. GUO Yike commenced his appointment as Provost of HKUST. Prof. Guo, most recently Vice-President (Research and Development) and Dean of the Graduate School at Hong Kong Baptist University, had previously spent 33 years at Imperial College London, including receiving his PhD there.

Prof. Guo, a Tsinghua University alumnus, is an expert in data mining for large-scale scientific applications, covering distributed data mining methods, machine learning, and informatics systems in areas ranging from biology to creative design, geophysics to healthcare, finance to social media. In addition to his responsibilities as Provost, Prof. Guo is concurrently a Chair Professor in the Department of Computer Science and Engineering. He is also the principal investigator of a HK$52.8 million Theme-based Research Scheme project, focused on AI-based art tech for human-machine symbiotic creation and funded by Hong Kong's Research Grants Council.

In January 2023, Prof. Hong K. LO took office as Dean of Engineering. Prof. Lo, Chair Professor in the Department of Civil and Environmental Engineering, is a smart transportation specialist and Founder-Director of HKUST's interdisciplinary GREAT Smart Cities Institute. The Hong Kong-born academic received his PhD in Civil Engineering from Ohio State University, moving on to Oak Ridge National Laboratory and University of California, Berkeley, before joining SENG in the mid-1990s.

Dean of Engineering Prof. Hong K. Lo

Prof. Lo has established himself as a driving force in the interdisciplinary transportation field, steering forward intelligent transportation systems, mobility system resilience, sustainable development, and smart cities.

Developing the way to net-zero carbon

Advancing corporate efforts to decarbonize through aligning company plans with climate science: Chair Professor Irene Lo, Civil and Environmental Engineering, and Mr. David Ng, Group Associate Director of Sino Group.

In a significant step forward for the developer sector and climate change mitigation, Ir. Prof. Irene LO, Chair Professor of Civil and Environmental Engineering, and her research team have collaborated with a major industry player to devise a practical holistic roadmap for the company to achieve net-zero carbon by 2050.

Working with Sino Land Company Ltd., one of Hong Kong's leading property developers, Prof. Lo has assisted in drawing up a Decarbonization Blueprint and providing science-based targets. The blueprint encompasses interim goals for decarbonization, including provisions for climate risk assessment for projects, to further enhance the company's risk management system. The roadmap is one of the first to be publicly released by a major developer.

Prof. Lo, an award-winning researcher and educator, has concentrated on originating environmental clean-up research solutions locally and internationally since joining HKUST in 1992. She is an Academician (Technical and Environmental Sciences) of the European Academy of Sciences and Arts, becoming Hong Kong's first member of the prestigious body in 2014. She is also a registered professional engineer and registered carbon auditor in Hong Kong and the US.

In 2021, Sino joined the Business Ambition for 1.5ºC campaign, initiated by a global coalition of United Nations agencies, business and industry leaders to advance efforts to decarbonize through aligning corporate plans with climate science. Sino then teamed up with Prof. Lo and her researchers. Following research and data collection, they went on to together devise decarbonization strategies and science-based interim targets covering the company's key areas of development, operations, and collaboration. These include setting percentage goals for reductions in greenhouse gas emissions and electricity use intensity as well as carrying out climate risk assessments and obtaining BEAM Plus Gold certification or above at Sino Land's wholly owned new development projects, where applicable. BEAM Plus is a top initiative in Hong Kong providing independent assessment of building sustainability performance.

The collaboration has provided a valuable opportunity to transform the team's research on decarbonization and carbon reduction into impactful solutions for the building industry and wider community, according to Prof. Lo. "Together, we are making important strides to drive sustainability and tackle the grand challenge of climate change," she said.

Mr. David NG, Group Associate Director of Sino Group, also commended the "stellar support and effort" from the HKUST team and Sino colleagues and stakeholders in propelling forward the net-zero carbon roadmap "to make progressive strides toward a low-carbon, climate resilient and sustainable future".

Prof. Lo and her team are now working on further net-zero projects with Sino related to the company's new Landmark South office and retail building in Wong Chuk Hang and a construction project on Peel Street in Central.

AI technology boosts patient safety

An AI-based guidewire recognition and counting technology, developed by Prof. Gary CHAN Shueng-Han, Computer Science and Engineering, and his research team, is helping to improve patient safety by reducing the risk of wires being left in the body following a clinical procedure.

The AI software, which rapidly and accurately recognizes all used guidewires removed from a patient, has been deployed at Tseung Kwan O Hospital in 32 cases from November 2021 up to February 2023, without missing a wire. Prior to the technology, medical workers had to manually count multiple times whether all guidewires had been taken out.

A guidewire is a thin wire used to guide placement of a catheter into a central vein to administer fluids or medication, or monitor blood flow stability. It is used in procedures employing the Seldinger technique, where a central venous catheter is inserted to give access to blood vessels and hollow organs such as the stomach and gallbladder.

The technology developed by Prof. Chan's team provides an "AI checker" using computer vision. Medical staff first confirm the number of guidewires as indicated by the system. They take and upload a photo of the guidewire(s), and perhaps other medical instruments, via a smartphone or tablet. Through object recognition and data augmentation techniques, the system can then detect guidewires and cross-check the manual count in real time.

"Compared to humans, our AI checker does not get tired or distracted and serves as an impartial tool to double check and validate manual counting," Prof. Chan said, noting the system maintains its high accuracy and efficiency over time. "Looking ahead, we would like to extend the technology from guidewires to other medical instruments to guard against retention inside a patient's body."

Prof. Chan is also working on location sensing applications to efficiently search for missing dementia patients or other mentally incapacitated persons (MIPs).

The "AI checker", based on computer vision, helps to ensure all guidewires (circled, right) have been removed from a patient's body.

Turning innovation into industry impact

Five HKUST advanced technologies are to be developed for application in industry following the signing of a licensing agreement with Guangdong Bright Dream Robotics Limited (BDR), which specializes in automation machinery R&D and manufacturing. The technologies mark the first outputs to emerge from the HKUST-BDR Joint Research Institute (HBJRI), a University-industry platform set up to promote innovation and nurture talents.

Established in 2019, the joint institute is working on around 20 projects related to robotics, AI, smart cities, materials, and big data. Most stem from real-life challenges facing industry, with faculty proposing solutions and Bright Dream Robotics testing the ideas. The innovations licensed comprise:

- A new inorganic coating that could help keep buildings cool in hot and humid climates by lowering the temperature by 2-3°C during day time and 6°C at night.
- A parallel compression framework containing three different compression algorithms to fit different environments and point cloud data. GPU-accelerated algorithms can be used in large-scale 3D map compression or in real-time autonomous driving systems.
- Wear-resistant, anti-corrosion, self-cleaning, superhydrophobic surfaces for building robots' metal components.
- Design and forming technology of large composites for building formwork and light-weight robots.

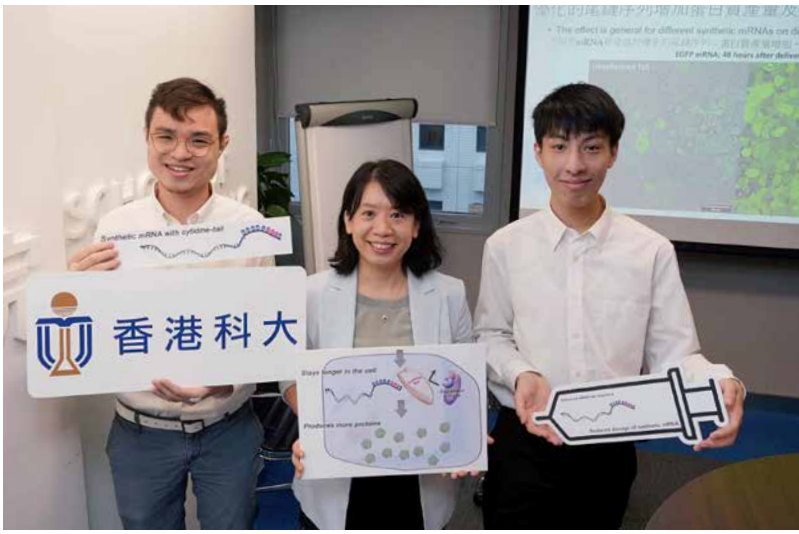
Spurring mRNA drug and vaccine effectiveness

A synthetic biology research team led by Prof. Becki KUANG Yi, Chemical and Biological Engineering, has discovered a way to enhance the lifespan and increase synthetic mRNAs' protein production efficiency by up to 10 times. The exciting advance can augment the effectiveness of mRNA vaccines and drugs, including those battling cancer, COVID-19, and genetic diseases, and at the same time use smaller dosages.

Synthesized mRNAs can teach cells to make proteins such as antigens and hormones that are essential to fight infections and regulate bodily functions. This means that mRNAs are often the preferred option for vaccines and treatment for many diseases. However, the need for high dosages and repeated injections to generate enough proteins in the body has made increasing mRNA effectiveness a key issue among researchers.

Having engineered different mRNA tail sequences, Prof. Kuang's team identified optimal sequences that could produce three to 10 times as many proteins as unoptimized tail sequences commonly used for synthetic mRNAs for both human cells and on mice. The duration of protein production also doubled.

In addition to reducing the amount and number of injections needed, the new technology could lower the cost of treatments. It can also be used along with other mRNA enhancement technologies to synergistically boost protein production. The finding was recently published online in *Molecular Therapy – Nucleic Acids*.



Prof. Becki Kuang (center) and team members Li Cheuk-Yin (right) and Liang Zhenghua, both PhD candidates, showcase their mRNA tail sequence optimization technology.

Prof. Kuang's team is now working in collaboration with Sun Yat-sen University in Guangzhou to explore optimized tails for mRNA cancer vaccines on animals. She also hopes to collaborate with pharmaceutical companies to transfer the innovation from lab to market.

- Integration of Building Information Modeling (BIM) data and a mobile map engine, enabling users to accurately and rapidly pinpoint people or facilities inside a building through their mobile phones.

Bright Dream Robotics President Mr. WANG Kecheng said that the partnership with HKUST had built a bridge between academia and industry, enabling research and knowledge transfer.

Meanwhile, Prof. Tim CHENG, Vice-President for Research and Development at HKUST and former Dean of Engineering, said that the signing of the licensing agreement exemplified HKUST's ability to create impact on society. "We will continue to forge and deepen our collaboration with industry to strengthen the University's endeavors in knowledge transfer," he added. (See also HKUST Industry Engagement Day, back cover.)

An inorganic coating to keep buildings cool is among the five recently licensed technologies.

Rechargeable battery breakthrough

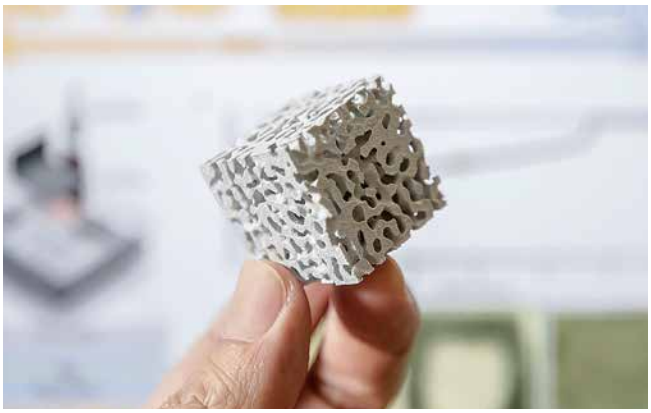
Hearing aids, flashlights, remote control devices, and other household items could become more sustainable in the future, thanks to a novel electrode design by School of Engineering researchers that enables the alkaline zinc batteries these devices use to become rechargeable.

The team, led by Prof. CHEN Qing, Mechanical & Aerospace Engineering and Chemistry, has developed a nanoporous zinc metal electrode capable of stabilizing the electrochemical transition between zinc and zinc oxide, successfully turning an alkaline zinc-air coin cell into a rechargeable battery stable for over 80 hours.

To do this, the team shaped zinc into curvy filaments hundreds of nanometers wide, nested in a freestanding solid with numerous, similarly narrow pores. When the battery is discharged, a thin layer of zinc oxide nucleates on the zinc filaments, preserving the metallic network and enabling the zinc electrode to return to its initial structure.

In addition, the team has tested the new electrode in alkaline nickel-zinc batteries. Results showed an increase from the normal lifespan of 50 to 80 discharges and charges to more than 200, under conditions competitive with state-of-the-art lithium-ion batteries.

Prof. Chen pointed out that alkaline zinc batteries had an edge over other batteries due to their safety, low cost and energy density. In industry, they are ideal for golf carts and forklift trucks, among others. They are also suitable for emerging applications, for example, back-up power for data centers, which do not need multiple discharging and charging but require the battery to be extremely safe.



A 3D model of the zinc electrode's nanoporous structure, magnified 10,000 times.

The research has been published in *Nature Communications*. Prof. Chen's group has also been working with industrial partners since the research started in 2018 to assist development and commercialization of the battery technology.

Key step forward for renewable energy

An international research team led by Prof. Francesco CIUCCI, Mechanical and Aerospace Engineering, has designed an iron-based cathode material that achieves record performance for protonic ceramic fuel cells (PCFCs), marking a significant step forward in the commercialization of this renewable energy technology.

Prof. Francesco Ciucci's iron-based cathode material has enabled protonic ceramic fuel cells to attain record performance.

PCFCs are generally used for distributed power generation and have the advantages of low pollutant emissions, high efficiency, and the flexibility of working well with hydrogen and other gases, including ammonia and biogas. However, a lack of high-performance and low-cost cathode materials have hindered development to date.

By combining first-principle simulations, molecular orbital analysis, and experiments, Prof. Ciucci's team has now designed ceramics using inexpensive elements such as barium, iron, and zirconium, leading to a PCFC with record performance.

The research has been published in *Nature Catalysis* and highlighted in *Nature Reviews Materials*. Team members include collaborators from Mainland China, South Korea, and Australia.

Inspiring human-centered creativity

A partnership between the School of Engineering's Division of Integrative Systems and Design (ISD) and the business community is successfully fostering students' empathetic design, systems thinking, and human-centered products through an enterprising scholarship award scheme.

The Chinachem PrimeMovership scholarships support ISD undergraduates and postgraduates with high achievements in innovative technology design and entrepreneurial potential.

Immersive learning for academically challenged students, and (right) a social robotic pet.

One awardee is postgraduate Iain LAM, who has founded Sallux Education, a center that uses technology to help academically challenged students in primary and secondary schools. An endeavor born out of Iain's own struggles with dyslexia and attention deficit hyperactivity disorder, his creative approach has improved the learning experience of such students by gamifying the process. With the help of headsets, students can become fully engaged in an immersive virtual learning environment, enabling them to focus on lectures and complete tasks in a non-distracting environment.

Scholarships also went to an undergraduate team for a project centered on a social robotic pet, which offers wellness support to isolated students. The palm-sized digital pet provides interaction and companionship to users with sound and visual feedback, and an emotional assessment to raise users' awareness of their mental health.

Prof. Winnie LEUNG, ISD, said: "Our ultimate goal is to nurture a new generation of innovators who can work across multiple disciplines and create disruptive innovations to solve the world's great challenges."

Robots build engineering interest

In a boost for science and technology know-how and enthusiasm among young learners, members of the School of Engineering helped the University organize the First Robot Explorer Cup competition in summer 2022, attracting over 110 students from 16 primary and secondary schools and their teachers. The contest formed part of a hands-on HKUST science, technology, engineering, and mathematics (STEM) program, launched in December 2021, whereby school students could learn about programming and 3D printing, and build their own robots through online workshops and a bootcamp.

The winning team came from TWGHs Yau Tze Tin Memorial College, with Pui Tak Canossian College as first runner-up. Lok Sin Tong Lau Tak Primary School was named second runner-up, and also received the Best Team Spirit Award. St. Margaret's Co-educational English Secondary and Primary School won the Best Engineering Award. The competition was funded by Bank of China (Hong Kong).

Young learners discover how robots work by putting together their own.

Goggles seek to prevent glaucoma

A shared goal to save people's sight has led a team of mechanical engineering students to invent an award-winning device to help prevent the progression of a devastating eye condition

Glaucoma causes progressive loss of vision over time and is the second-leading cause of blindness worldwide. It is estimated that 80 million people globally suffer from glaucoma, known as the "silent thief of sight" due to its capability to cause irreparable damage to the optic nerve before symptoms are detected. Yet preventive therapeutics are still in short supply.

Now, four students from the Department of Mechanical and Aerospace Engineering have set out to change this through their creative invention: an easy-to-use wearable device suitable for those diagnosed with mild and pre-glaucoma, and with the potential to expand to all people who care about the health of their eyes.

In September 2022, the team comprising mechanical engineering students KWOK Kin-Nam, PhD Year 5 (pictured, second left), Minji SEO, PhD Year 1 (first right), CHAN Kwun-Chung, BEng Year 4 (second right), and LEUNG Yuen-Yin, BEng Year 3 (first left), took home the Hong Kong James Dyson Award for their innovative O_Oley goggles. The O_O symbolizes the novel eyewear.

The high-profile international contest aims to inspire the next generation of design engineers in line with the creative outlook of competition founder and renowned industrial designer James Dyson. The team's achievement has injected £5,000 (around HK$47,500) into the students' research project, enabling them to patent the design and launch a start-up to take the invention forward. The project is led by Prof. David LAM and supervised by Dr. Stanley LEUNG (both Mechanical and Aerospace Engineering).

Damage caused by glaucoma is a result of sustained build-up of internal eye pressure, known as intraocular pressure (IOP). While it is known that massage and hot towels relieve tired eyes, such applications are insufficient for relaxing intraocular tissues. The comfortable, curved-shell O_Oley goggles take this forward by allowing users' eyes to undergo contactless thermal stretching.

The invention comprises a corneal tissue compliance improvement (CTCI) system and an ocular cell rejuvenation (OCR) system. The CTCI system regulates the goggle chamber pressure and increases the chamber temperature to massage the corneal tissue in a contactless way. The OCR system utilizes activation light at specific wavelengths and infrared irradiation to energize intra-cellular activities as well as promote blood circulation within the ocular region.

"O_Oley is like 'hot yoga' for your eyes"

"O_Oley is like 'hot yoga' for your eyes," Kin-Nam said. "It lowers your eye pressure by stretching the ocular surface and allows it to relax under a controlled, heated environment." Given that the structure of the eyes is similar to a balloon, as the surface gets stiffer and tenser, air pressure builds up from within, he explained. O_Oley is designed to reduce that stress, halting the progression of glaucoma.

In a departure from other glaucoma treatment for diagnosed patients, O_Oley is non-invasive, providing a warming therapeutic experience that can be carried out daily at home. Beneficiaries include patients and people with a higher number of glaucoma risk factors, such as the elderly, individuals with high eye pressure, high myopia or hyperopia, and those with a family history of glaucoma, with the potential to expand coverage to all people suffering from eye strain associated with digital and urban lifestyles. In an unexpected further benefit, O_Oley has proved effective in relieving dry eye symptoms.

As with many innovations, the creative journey has not always been straightforward. One particularly discouraging stage occurred near the beginning when trial participants' IOP remained constant despite all the team's hard work. "At that time, we inched ahead as months went by. Frankly, we once thought about giving up when developing the prototype," Kin-Nam said. "The Dyson Award came as timely assurance. It was such an honor to see our innovation win buy-ins and recognition. We bounced back and gained renewed confidence to turn things around again."

Team spirit was another major factor driving the students on. A well-mixed team of male and female, local and international, postgraduates and undergraduates, the four members proactively combined their strengths to build collective knowledge, challenged one another to think from different perspectives, and sought to integrate each person's insights and contribution to create the best possible solution. Moreover, from the start, they were of one mind as to what they wanted to achieve.

"Who knows... one day, we might be the beneficiary of our own invention"

"Even if O_Oley hadn't generated positive trial results, we believe we would have taken an alternative route and developed another device to achieve the same purpose," Kin-Nam said. "Because right from the beginning, our goal has not been to commercialize a product but to create something that serves glaucoma patients. Every step we take is oriented to that goal. Who knows... one day, we might be the beneficiary of our own invention."

What's in a word

School of Engineering students also won the runner-up accolade in the Hong Kong James Dyson Award. The team's PreDyctor is the world's first dysgraphia identifier for Chinese handwriting. The advance offers a rapid, inexpensive pre-screening system that can assess Chinese characters and estimate the chance that the writer has dysgraphia, to assist early intervention. Dysgraphia is a learning disorder associated with impaired writing ability. The research team, all from the Class of 2022, comprised NIE Fei, BEng in Computer Science (pictured, bottom left), ZHOU Xinrui, Dual Degree Program in Technology and Management (bottom right), ZHAO Yankun, BEng in Computer Science (top right), and ZHAO Yizhe, BSc in Computer Science (top left).

Getting real about the metaverse

HKUST is setting out to help shape the digital world of immersive learning that frontier augmented and virtual reality technologies are opening up, as well as alert people to the societal issues that such realms will need to address in their development

Imagine taking a course in a lecture theater filled with avatars, including the speaker's and your own. Imagine a class where the professor greets the 100 students present, 50 in person and 50 apparently there but actually located at a campus around 100km away. These scenarios may seem futuristic. However, such total virtuality[1] and mixed reality[2] environments for education are almost here, with initial trials underway as part of MetaHKUST, the University's go-ahead extended reality[3] initiative.

Prof. Pan Hui at HKUST(GZ): pioneer of virtual and augmented realities.

And this is only the beginning for the engineering and emerging technologies' venture. By the end of this year, it is expected that the avatars populating HKUST's 3D virtual classroom will possess the facial features and mannerisms of the students and lecturers they represent, with real-time reactions that echo their human counterparts. The classroom's look'n'feel will be enhanced and scaled up to accommodate 200 or more users. Within three years, it is planned that HKUST and its recently opened HKUST(GZ) campus in Nansha, Guangzhou, will each be operating a physical classroom, equipped with state-of-the-art sensors and motion-capture cameras for the more technically challenging mixed reality learning environment, as well as sharing use of the virtual reality classroom.

These arrangements will enable students from both campuses to meet each other and learn together in real time without actually traveling between the two locations. It will allow HKUST students, guest learners and lecturers from other institutions to attend remotely. Broadening out from classes, there will also be a digital twin up and running for each campus, with the expectation that MetaHKUST will add convenience and greater efficiency to multiple aspects of University life. Examples range from visiting the Finance Office and accessing advisory services to receiving blockchain-secured diplomas or transcripts in the form of non-fungible tokens (NFTs).

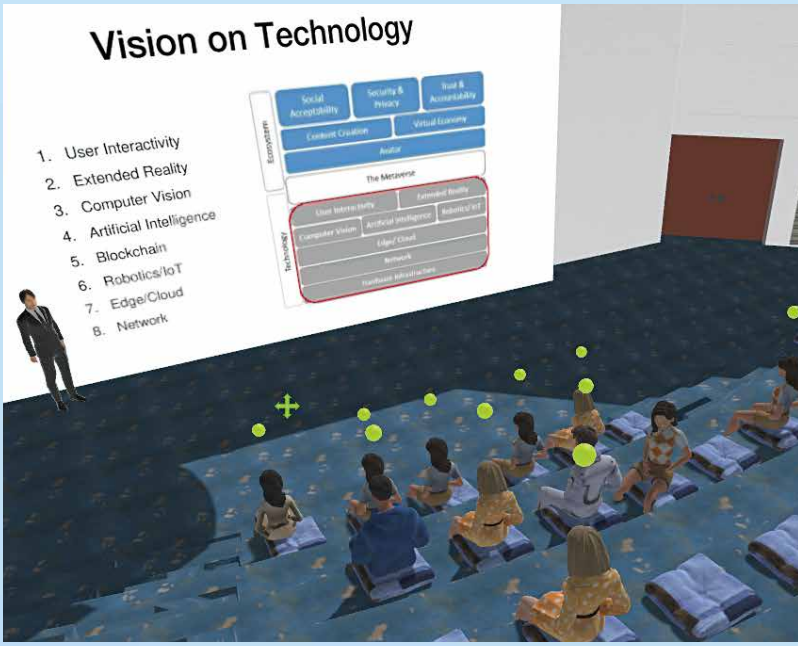
Implementing MetaHKUST turns the "Unified HKUST, Complementary Campuses" vision behind the two campuses' operations into a working model. Moreover, it becomes possible to identify the real research challenges of building a large-scale teaching and learning meta environment, according to Prof. Pan HUI, one of the international trailblazers of research and development in augmented and virtual realities and a core mover behind the initiative. As one of the first higher education institutions to build and explore the challenges of such a scalable endeavor beyond gaming, it also offers a way for HKUST researchers and educators to play a significant part in shaping the overall metaverse, now at its formative stage, "the very, very beginning", Prof. Hui said.

What is the metaverse? The *Encyclopedia Britannica* definition is a "proposed network of immersive online worlds" where users interact with each other and consume services and goods through virtual or augmented reality technologies,

[1] Simulated experience with 3D near-eye displays of an immersive virtual world + user interaction.

[2] Augmented reality (digital overlaid on the physical) + user interaction.

[3] Augmented, virtual, and mixed reality.



Students attend a lecture remotely in HKUST's virtual reality classroom using their avatars during a recent trial of MetaHKUST technology. The aim is to scale up to 200-plus users.

with the issue of how the different worlds and communities will seamlessly interconnect to enable users to move across the platforms (interoperability) yet to be resolved.

What these worlds will comprise, their design, and standards are also undetermined on a collective basis. For Zuckerberg followers, the metaverse is a utopian creation where people work, socialize, and play games. Business people see a burgeoning realm of market opportunities expected to reach US$800 billion in 2024, according to a Bloomberg forecast. For Prof. Hui and his research team, it is a fascinating technical and societal quest, with the potential for more accessible education, greater social equality, and better communication across the world, as well as major issues that need to be addressed related to privacy, governance, and data security, among other thorny areas.

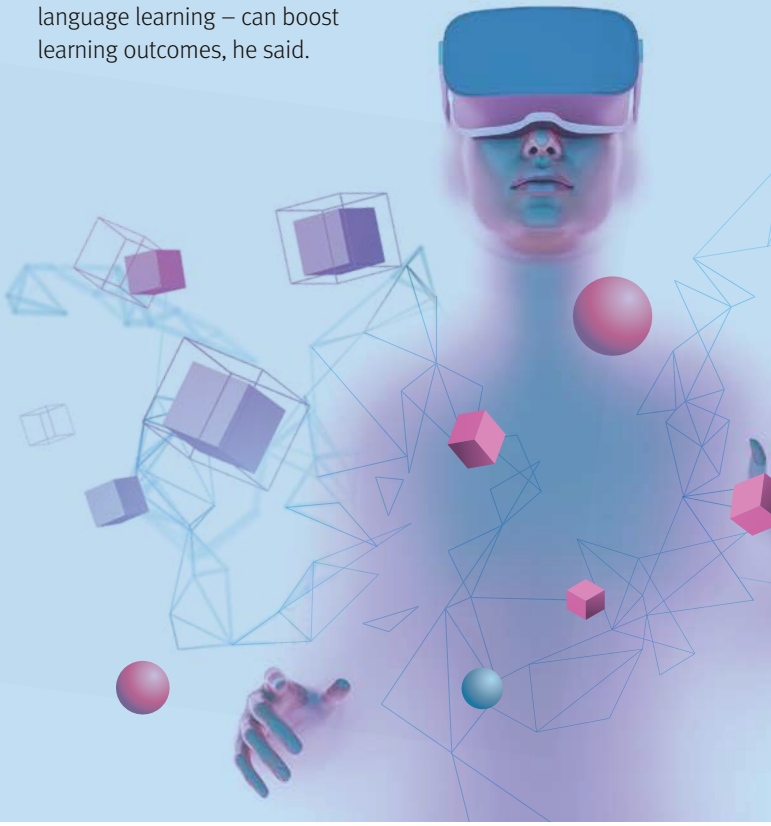
Prof. Hui, who joined HKUST in 2013 as a member of the Computer Science and Engineering at the School of Engineering, is now Chair Professor of Computational Media and Arts, and Director of the Center for Metaverse and Computational Creativity at HKUST's new Guangzhou campus. At the Clear Water Bay campus, he is Chair Professor of Emerging Interdisciplinary Areas, and long-time Director of HKUST-DT System and Media Laboratory, a joint arrangement with Deutsche Telekom Innovation Laboratories, researching virtual reality and augmented reality systems, social media, big data, and mobile computing.

The avatar of HKUST(GZ) President Prof. Lionel Ni (left) takes a virtual torch from HKUST Founding President Prof. Woo Chia-Wei's avatar at the opening ceremony for the Guangzhou campus (see also P15 box). The real President Ni then placed a physical torch on the main stage.

His own introduction to different kinds of reality started after his undergraduate studies at the University of Hong Kong (HKU) in the 1990s when the internet was the hottest technology of the day for those in electrical and electronic engineering and computer science. A months-long cycling trip to internet-less Tibet in 2002 ahead of starting his HKU MPhil postgraduate studies made him curious about alternative communication networks when the internet is not working or accessible. This led on to his PhD (2008) at the University of Cambridge exploring short-range radio, human mobility, and centered on bridging mobile and social networks. He then worked at Deutsche Telekom Innovation Laboratories in Berlin, Germany, on cutting-edge cloud computing applications before deciding that augmented reality would be the technology of the future, not only for him but everyone else.

"In the beginning, nobody knew what was going on with online social networks. Now people have learned... and know they need to be more careful"

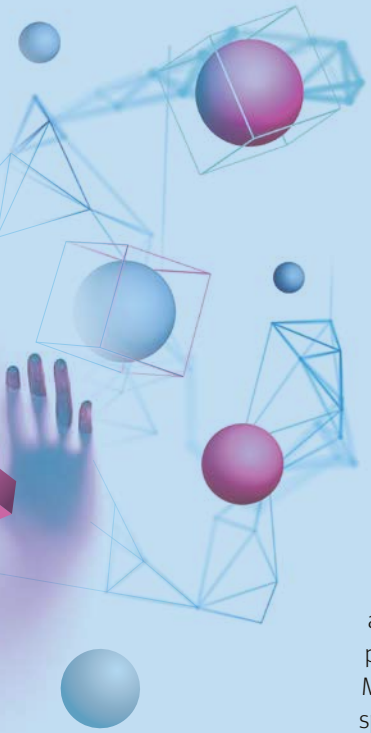
In the past 10 years, Prof. Hui has focused on building high-performance, energy-efficient and scalable software for mobile wearable devices and cloud systems; and devising mobile augmented reality algorithms and systems for immersive data visualization and human-data interaction. His published papers now total more than 450, with over 25,000 citations. He also has 32 European and US patents. The concept of MetaHKUST arose at the end of 2021 when students were tiring of the limitations of learning via 2D videoconferencing technologies and extensively used during the pandemic. Rather than a sense of being outside looking in, classrooms using 3D virtual reality or mixed reality offer students a way to feel "present". These perceptions are an essential part of the learning experience, with global research already showing that immersive experiences in general – such as in-country language learning – can boost learning outcomes, he said.



Wearing a headset and represented by their avatar, the 20-30 students in MetaHKUST's November 2022 trial were able to enter the University's virtual reality classroom remotely, take a seat, move around, and go up to the professor and talk to him or her. "As they don't see their own avatar, psychologically, they feel part of that environment," Prof. Hui said. "You can just turn your head and see other students. You can move around. Education users want some self-presence. You feel the experience is better. With videoconferencing, I cannot move to see another person." In a mixed reality classroom where a real person can be projected, the "immersive presence" will be even stronger, he noted.

Such work involves a host of cutting-edge technical challenges for his team of postdocs, postgraduates, and undergraduates, from over 10 different countries (he is a firm believer that diversity sparks creativity and new perspectives after his own multicultural experiences at Cambridge and in Berlin, among others). System architecture for mixed reality classrooms, user interactivity and perception challenges, and latency issues are just some of the topics being tackled.

HKUST academics from a range of disciplines are also participating. These currently include Prof. WANG Yang, Vice-President for Institutional Advancement, who is the leader and driver of MetaHKUST development at the Clear Water Bay campus, Prof. Kani CHEN, Industrial Engineering & Decision Analytics and Mathematics, and Prof. Tristan BRAUD, Integrative Systems & Design and Computer Science & Engineering, both in the School of Engineering. At HKUST(GZ), Prof. WU Jingshen, Vice-President for Teaching and Learning, has been pushing forward the mixed reality classroom construction and development and many students from his Red Bird MPhil Program have chosen MetaHKUST as their MPhil research projects. The aim is to expand the project to more faculty and students at both campuses to accelerate advances.



But technical issues are not the only ones covered in a growing number of publications, and postgraduate theses' topics alongside implementation of the physical and virtual classrooms of MetaHKUST. The initiative is also spurring the exploration of societal questions arising from the extension of virtual and augmented reality technologies into different areas of people's lives.

A particularly popular contribution is the comprehensive "All One Needs to Know About Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda" (2021), a paper available to specialists and non-specialists via the Creative Commons. In one of the first publications of its kind, Prof. Hui and his co-authors consider not only the impact of metaverse-related technologies but the broader ecosystem such a development encompasses: the virtual economy and content creation, social acceptability, security and privacy, trust and accountability, and the behavior and potential immortality of people's avatars. The paper has attracted more than 500 citations and over 111,000 individual user reads, and brought many invitations from different sectors for Prof. Hui to discuss the metaverse.

Among recent speaking engagements, Prof. Hui was invited to join a panel discussion in October 2022 at the 90th INTERPOL General Assembly. INTERPOL's membership

Seeing the future

Early MetaHKUST demonstrations include an animated dragon entering a mixed reality classroom (scan QR code, or available on YouTube). Meanwhile, large-scale virtual reality was in action at the opening of the HKUST(GZ) campus in September 2022, attracting great media attention. Guests, including overseas higher education presidents and senior management, business leaders and long-term University partners, could either attend in person or send their avatar – a useful as well as memorable way to be present given the difficulties of traveling during COVID-19.

connects police forces across 195 countries. Its annual assembly drew 1,000 security ministers, chiefs of police, and other delegates from around the world in New Delhi, India, including Hong Kong's police commissioner. "I've never felt so safe!" Prof. Hui said. Activities at the assembly included the unveiling of the first metaverse designed for law enforcement, which is being used for training. As a founding member of the INTERPOL expert group on the metaverse, Prof. Hui will be working closely with law enforcement specialists globally to raise concerns and try to make these realms safe.

In providing societal input, Prof. Hui sees a special role for academia in evolving the metaverse. "Sometimes the big tech companies may not have such things in mind when they design their metaverse as they are more interested in the commercial aspects. But as academics, we have to push more on the ethical, societal side. While we focus on technological development of the metaverse, we can also identify what other potential issues there are and voice them as early as possible so that society knows about them.

"In the beginning, nobody knew what was going on with online social networks (OSNs), that people could be so manipulated. If this can happen with OSNs, it can happen in the metaverse. But now we have learned from everything that has happened with social networking and people know they need to be more careful."

Raising awareness in this way is particularly important, for Prof. Hui. An IEEE Fellow, International Fellow of the Royal Academy of Engineering, and Member of the Academy of Europe, he views the development of the metaverse as the future that awaits us. He sees people want convenience, business wants efficiency, and both want communication. The three combined will ensure that as virtual and augmented reality technologies improve, more and more content will become available and incorporated into people's lifestyles. They will be used to hold meetings, when people sit in restaurants, or to call up information overlaid on locations they are visiting.

Prof. Hui views the development of the metaverse as the future that awaits us

"Fifteen years ago, we didn't have smartphone. At that time, people wouldn't believe that you would use your phone to do all the things we use it for today. Now we can't go out without bringing our phones. Similarly, people will get used to virtual content," he said.

It is also why Prof. Hui feels it is imperative at this formative time that it is shaped to be a "better metaverse". "A metaverse, with respect, accessibility and equality, enabling more global collaboration by providing a platform for people from different regions to communicate, study, and learn immersively," he said. "A metaverse for good."

Members of the multicultural MetaHKUST research team, with Prof. Hui (second row, third right) and Prof. Wang Yang (second row, third left).

Fun pathways to full-potential engineers

By Prof. Kenneth Leung

Happy classes make happy students. As a firm believer in engaging, motivating education, and in making the acquisition of knowledge fun, I always do my best to create a positive teaching environment where students feel cared about and supported. An essential component is to maximize the learning potential of each student in my classes. The positive teacher-student relationship also motivates students to participate and engage in all aspects of their learning, and thus stimulates their curiosity and interest in exploring more about computer science, my main field. "You may be shy at the beginning, but we will all become friends by the end of the semester," I always say to my students when we first meet.

An inspiring learning environment is especially important for classes with difficult theoretical subjects. My award-winning common core course on "Discrete Mathematical Tools for Computer Science" (COMP 2711) introduces mathematical theories that some students may consider difficult. To stop them losing interest before they get to the "fun" part, where they apply their new knowledge to real-world computer applications, I employ gamification and content such as brain teasers to engage students in critical thinking, build collaborative learning, and sustain enthusiasm.

In COMP 2711, the gamification system not only generates more sample questions, but also allows course participants to design and share their own questions. Designing questions requires students to have a good understanding of the materials covered in class and helps them gain a deeper understanding of the topics covered.

"The wide adoption of blended learning and experiential learning at HKUST School of Engineering ultimately equips and inspires students to embrace boundless possibilities in their future lives"

Technology offers other pathways to a more engaged environment for learners. Take the cloud-based instant messaging channel I utilize in my classes. This enables students to raise questions on course topics and beyond and take part in discussions among themselves as well as with teaching assistants and myself. Such interaction leads to valuable peer learning and mutual support, along with great camaraderie.

Meanwhile, solving real-world problems is one of the most exciting aspects of a career as an engineer. The wide adoption of blended learning and experiential learning at HKUST School of Engineering creates a host of opportunities for students to develop knowledge and skills from direct experience and, ultimately, equip and inspire them to embrace boundless possibilities in their future lives.

Indeed, the University is a regional leader in implementing new pedagogies – blended learning, experiential learning, massive open online courses (MOOCs) – to enhance the student learning experience. With HKUST's support, I have developed a series of blended learning and MOOCs to promote science, technology, engineering, and mathematics (STEM) education, and have accumulated over 100,000 learners around the world. Such pedagogies have proved especially effective during the COVID-19 pandemic. They also have a significant role to play in opening up motivational, quality education to a wider audience locally, nationally, and globally.

st century engineers

Prof. Kenneth LEUNG is Assistant Professor of Engineering Education in the Department of Computer Science and Engineering. He was the project leader for the Teaching Development Grant projects "Flipping the Classroom with iPad" and "Social Gaming Platform for COMP 2711". He received the HKUST Common Core Teaching Excellence Award in 2021 and an Honorary Mention in 2019.

Unlocking healthcare secrets of sweat

An early career faculty member's convenient, wearable biosensors are offering a novel technological avenue for people to gain fresh insights on perspiration and wellness

Perspiration is a bodily function that people often prefer to hide. However, for Prof. Hnin Yin Yin NYEIN, Chemical and Biological Engineering, the value of sweat is due for a rethink. "Sweat," she pointed out, "is an underutilized resource with enormous potential in facilitating active, non-invasive, and accurate health monitoring." Now the rising academic star is setting out to bring sweat back into the spotlight, along with greater recognition of the wealth of insights it offers into the dynamics at work inside us.

Prof. Nyein, selected for *MIT Technology Review*'s Innovators Under 35 Asia Pacific 2021, is doing so by developing flexible wearable biosensors that utilize our sweating response to provide personalized and preventative healthcare in areas such as metabolism and psychological stress.

Her cutting-edge sensors use resting sweat as a constant biofluid source to assess health metrics at a molecular level. The sensors are small, disposable and versatile, and can be tucked into wearables such as wristbands. They are also straightforward and cost-effective to mass produce, providing accurate analysis of the wearer's condition and enabling users of all ages and states of health to routinely track their physiology.

The sensors represent a technological breakthrough in the field, opening up on-going sweat monitoring without special collection procedures having to be carried out and paving the way for the potential transformation of diagnostic methods for some diseases.

One candidate is cystic fibrosis, where the conventional test for diagnosis is to measure the chloride ion level in sweat. This requires patients to remain still while their sweat glands are stimulated for sweat to be collected. Patients then need to endure a further wait until lab results are returned. Prof. Nyein's electrochemical sensors instead

offer near real-time sweat stimulation, collection, and analysis in one wearable as the sensors allow for local sweat stimulation. They are optimized to enable rapid uptake of an ultralow sweat secretion rate and can perform immediate and accurate sweat composition measurement and analysis with a volume as little as 40 nanoliters.

Furthermore, the technology can be used to measure other molecular constituents of sweat, Prof. Nyein noted. “If a disease’s indicator is involved with sweat biomarkers, we can collaborate with healthcare professionals and modify the sensor technology for a specific application.”

Beyond healthcare, sports science is a likely beneficiary, with the sensors able to estimate an athlete’s loss of body fluid, electrolytes, as well as sweat. “We are already having conversations with sports labs and athletes to conduct further studies. This could potentially benefit athletes by helping them find their best condition and optimize their performance,” she said.

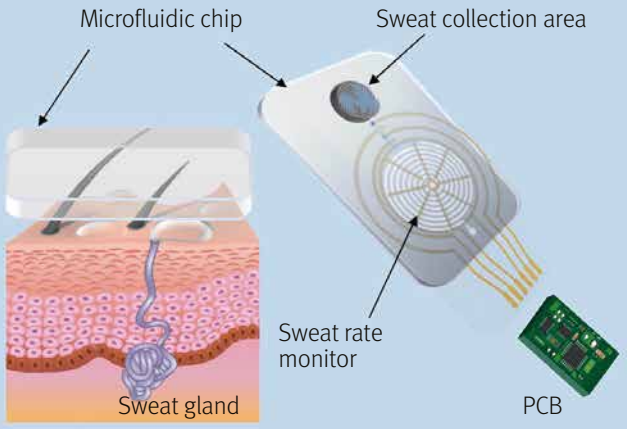
Born in Myanmar, Prof. Nyein earned her bachelor’s degree and PhD in Materials Science and Engineering at the University of California, Berkeley, going on to join Stanford University as a postdoctoral fellow. In addition to her Innovator recognition, Prof. Nyein’s research has been published in eminent scientific journals such as *Nature*. She joined HKUST in mid-2022, where she is relishing the dedication and dynamism of the School of Engineering’s research environment and fellow faculty members as she prepares to take her technology to the next stage of development.

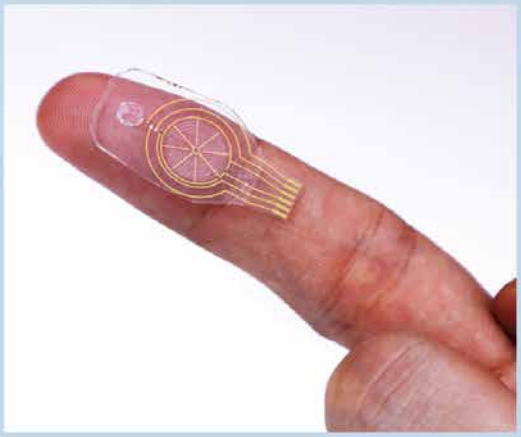
In the next five years, Prof. Nyein’s goal is to acquire a large set of data and map out a baseline representing a healthy and equilibrium body condition. If a user’s sweat measurements deviate from the healthy baseline, it might be an early indicator of a developing health condition, warning the user to get a medical check-up.

To uncover correlations between sensor measurements and health status, and determine subsequent actions that could be taken, it is essential to involve experts with core competencies in data analytics, she explained. “We will need help from big data and machine learning specialists to analyze the large database and extract meaningful insights. Lots of interdisciplinary and collaborative research will be required for this idea to become successful.”

As Prof. Nyein believes that a positive impact on society is the ultimate goal of every research endeavor, she is looking forward to this challenge and to passing on her expertise to students, empowering them to become creative changemakers for society in the future. “Not every career offers the opportunity to do what we love while enabling us to mentor the younger generation and help them make a real-world impact,” she said. “I am proud and honored to be able to do both at HKUST at this stage of my career.”

Biosensor benefits





Sweat rate optimization
Nyein sensors allow rapid uptake at low secretion rates through use of a rigid hydrophilic filler topped with a thin hydrogel in the collection well.

Minimal measurement delay
Fast collection reduces the time that sweat stays on the skin and facilitates near real-time sweat monitoring.

On-the-spot analysis
Assessment of sweat rate and compositions can be carried out inside the microfluidic channel.

Molecular-level metrics
Accurate molecular quantification with a volume as small as 40 nanoliters and operational stability up to 24 hours.

The joy of innovation

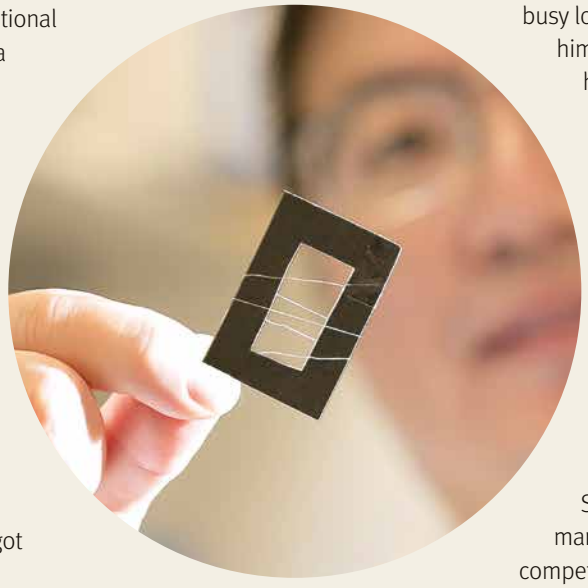
From hydrogels to spider silk, Prof. Sun Fei is on the discovery trail for therapeutic drug delivery advances, and is taking the next generation of young inventors with him

Prof. SUN Fei, Chemical and Biological Engineering, is on a creative mission. His current goal is to smarten the delivery of drugs in the human body by harnessing the silk produced by spiders to build their webs. Along the way, he is setting out to transfer to students and early career researchers the exhilaration of innovation and versatile thinking through such adventures at the frontiers of knowledge.

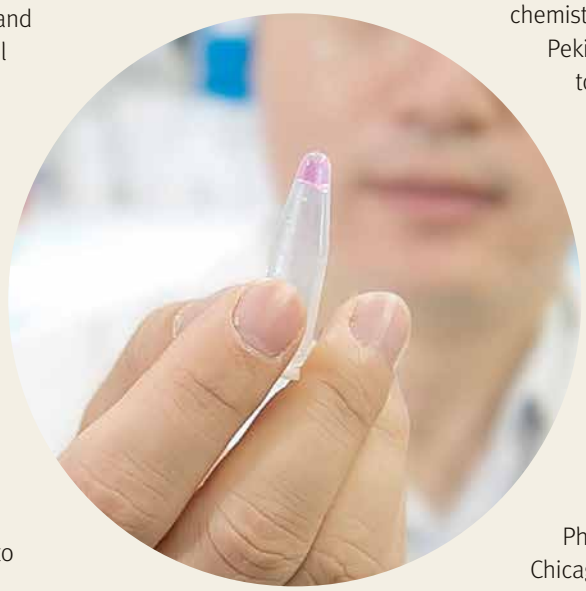
"Spider silk, or what some people call 'biological steel', is strong and stable," he said. "Unlike worm silk that can be mass produced for clothing, spider silk can potentially be used as a delivery device for drugs to help axon and bone regeneration and involves a more complicated production process."

Prof. Sun Fei relishes uncovering new protein-based engineering technologies, whether using spider silk (opposite, top) or creating his smart hydrogel (opposite, below).

For Prof. Sun, selected to receive National Natural Science Foundation of China (NSFC) Excellent Young Scientist funding in 2021, it is the discovery of the new that captivates him, with his own career journey echoing this passion for exploration. From his initial interest in chemistry, he moved on to chemical engineering. He is now devising novel synthetic biology approaches to make and transform materials and tools with "living" features.



Prof. Sun's drug delivery advances got underway with a protein-based stimuli-responsive smart hydrogel. This had the potential not only for drug delivery and stem cell therapy, but also to control the time and manner of delivery inside the body due to its light-sensing capability. The creation of entirely protein-based hydrogels represented a pioneering way to design bioactive materials with precise control of their properties. The invention then inspired three HKUST postgraduates to form biotechnology start-up, SPES Tech, to take this forward. The company, established in 2019, saw its flagship hydrogel "LitGel" move to commercialization in late 2022.



"Sometimes good ideas need a spark. This may come from your students or colleagues next door. An inclusive and intellectual culture is very important"

Recently, through a combination of materials science, synthetic biology, and genetic engineering, Prof. Sun has been seeking to utilize the possibilities of the steel-like protein fiber created by spiders for further therapeutic pathways. His lab is already capable of producing a spider's web and his researchers are working on protein engineering strategies to functionalize spider silk material. A provisional patent in the US has also been filed.

Prof. Sun's love of the original and unfamiliar – and the learning that takes place to comprehend them – began at an early age. Born in the late 1980s and growing up in the countryside of Yancheng, Jiangsu Province, he was a voracious reader from a young age, keeping his parents busy looking for different materials for him to devour. He tackled books on history, science, novels, or "anything printed, unselectively", he said.

The breadth of knowledge gained got Prof. Sun off to a good start at school. He became a top student, winning multiple provincial competitions in physics, chemistry, and mathematics. Later, he earned a place at Suzhou Experimental High School, going on to attain full marks for chemistry in China's highly competitive National College Entrance Examination. In 2003, he enrolled as a chemistry undergraduate at prestigious Peking University, where he continued to win awards.

At Peking U, the youthful mental explorer also began to investigate the world of research, joining a major organic chemistry project as a second-year undergraduate and working for two years alongside postgraduates in the lab to synthesize a natural organic compound useful for medical treatment. He went on to pursue a PhD in Chemistry at the University of Chicago under supervisor Prof. HE Chuan in 2007, followed by postdoctoral studies in chemical engineering at the California Institute of Technology (Caltech) from 2012-14, under Prof. Frances H. ARNOLD, 2018 Nobel Laureate in Chemistry.

During his time in the US, Prof. Sun not only expanded his understanding of the world through his studies but via the diverse people he met, seeking out friends from all walks of life and countries, sharing knowledge, and in turn gaining inspiration. It was at Caltech, he realized the crucial role of versatility for researchers and academics, including the ability to listen to others and keep an open mind to achieve this. He quotes the Confucian saying, "君子不器", which stresses the importance of embracing new knowledge and always being prepared for change.

With postdoc supervisor Prof. Frances H. Arnold, 2018 Nobel Laureate in Chemistry, at Peking University.

From Prof. Arnold, he also learned what to look for when joining a university – its ability to draw outstanding students – a critical factor for Prof. Sun in moving to HKUST as a faculty member in 2014. "HKUST is able to attract good students, and people are the most important. This was what Prof. Arnold told me – to find good students, you have to go to the place where they go."

In his role as educator of the next generation, Prof. Sun quotes another Chinese saying, "弟子不必不如師，師不必賢於弟子", which notes that students are not necessarily of lower ability than teachers, and teachers are not always more competent than their students.

He believes "the best education takes place in the lab where students are motivated to identify and solve problems". And, rather than pushing for publications, he considers it more important that emerging talents find their own identity and conduct research that is conceptually original.

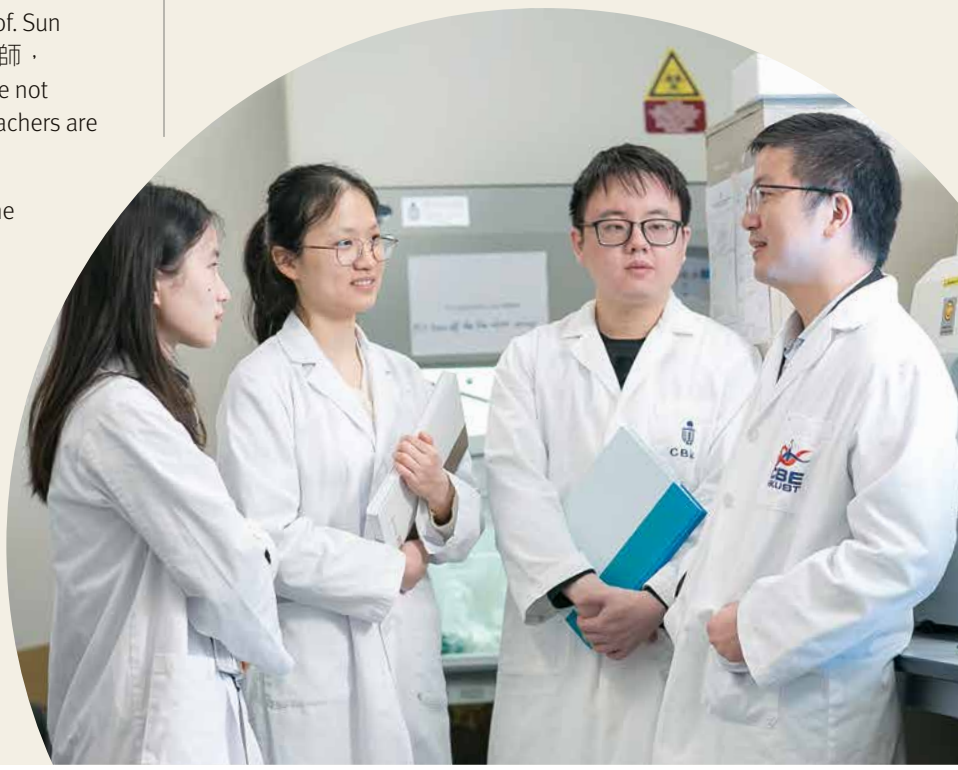
As Prof. Sun himself has done, he suggests students stay versatile by learning from everyone who touches their lives. "Talk to whoever you come across and be ready to share stories with each other," he said. In this, he said, Caltech and HKUST "are quite similar as students and professors are wonderful and willing to share". "You can chat with people casually for half a day. Sometimes good ideas need a spark. This may come from your students or colleagues next door. An inclusive and intellectual culture is very important."

Meanwhile, he is continuing to play his part in generating the inspiring research environment to keep brilliant young minds fully engaged and at the forefront of research discoveries. With his NSFC Excellent Young Scientist grant money, he is boldly setting out to test fresh ideas. "One direction is to explore the feasibility of using genetically engineered single cells as building blocks to create functional living materials, which can grow, self-propagate and self-heal," he said.

"As researchers, we always try out new, risky ideas. We explore the unknown, the unanswered, and the unfinished"

It is this energizing curiosity, combined with the resources to venture down untried avenues, that makes research such a rewarding endeavor, Prof. Sun noted. "As researchers, we always try out new, risky ideas," he said. "We explore the unknown, the unanswered, and the unfinished. Often we are more excited about unexpected outcomes than expected ones. If everything works as we expect, there would not be much fun. At universities, we can work on blue-sky topics."

Being in the lab motivates students to identify and solve problems, according to Prof. Sun.



Celebrating together

(From left, clockwise) Alumni enjoy the in-person summer mixer and tour of two HKUST-led InnoHK Centers.

Summer 2022 saw the happy return of in-person gatherings for School of Engineering (SENG) alumni, despite social distancing requirements limiting the number of people sitting together.

SENG's Alumni Summer Mixer brought together engineering graduates from across the years to celebrate HKUST's 30th anniversary. The June event took place at Hong Kong Science Park, with support from two of the HKUST-led InnoHK research centers based at the park: the AI Chip Center for Emerging Smart Systems (ACCESS); and Hong Kong Center for Construction Robotics (HKCRC). InnoHK is a major Hong Kong government initiative to transform the city into a hub for global research and development collaborations.

At the mixer, participants had the opportunity to go on exclusive tours of the two centers, rekindle bonds with old friends, faculty members, and staff, and forge new ties with fellow alumni and current students. More than 160 members of the SENG community joined the get-together, which was co-organized by the School and Hong Kong Science and Technology Parks Corporation.

Brothers who are giving back

Adding to HKUST's 30th anniversary celebrations, SENG alumni entrepreneurs and brothers Terry TSANG (2006 MPhil in Civil Engineering, 2004 BEng in Civil and Structural Engineering) and Terence TSANG (2006 BEng in Computer Science [Information Engineering]) pledged to donate HK$10 million to the University. The gift will provide HK$7 million to support University development through a donation matching initiative and HK$3 million to HKUST Business School's MBA program, which Terry (Class of 2018) subsequently undertook. Under the matching program, every dollar donated to the University's Alumni Endowment Fund will be matched individually by the two brothers, making each donation go even further.

And the forecast for tomorrow is...

The first graduate of Hong Kong's first academic-industry dual master's degree program on power engineering explains how the combination of theory and practical insights led to an innovation now accelerating energy optimization in the city

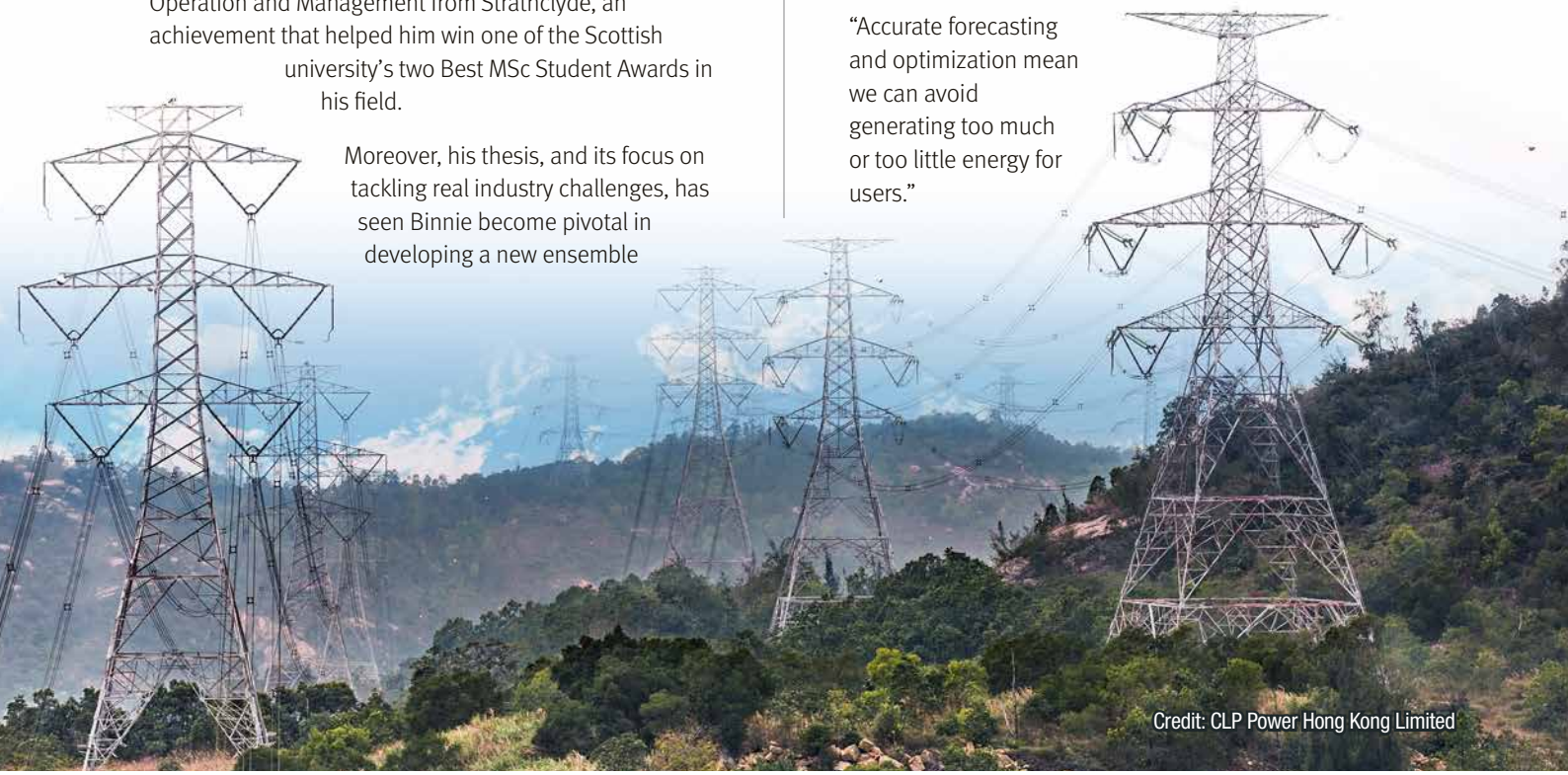
It has been three years of firsts for alumnus Binnie YIU Wai-Keung. In 2019, the then 30-year-old engineer at CLP Power Hong Kong Limited (CLP) was selected to join the inaugural cohort of Hong Kong's first joint academic and industry-run dual master's focusing on power engineering. Co-offered by HKUST, the University of Strathclyde, and CLP Power Academy, the part-time postgraduate program provided exactly what he needed as a working member of the energy sector: the opportunity not only to update his knowledge on the latest developments in science and engineering, but also to gain a fuller picture of the energy industry and CLP.

Binnie went on to become the program's first graduate in summer 2022. He received an MPhil in Computer Science and Engineering* from HKUST, along with an outstanding grade point average. In addition, he earned an MSc with distinction in Future Energy and Power System Smart Operation and Management from Strathclyde, an achievement that helped him win one of the Scottish university's two Best MSc Student Awards in his field.

Moreover, his thesis, and its focus on tackling real industry challenges, has seen Binnie become pivotal in developing a new ensemble model to handle load forecasting, advancing power optimization at CLP. This model is now in operation. And as CLP is one of the two major electricity companies in Hong Kong, it means Binnie has assisted in boosting power efficiency for its six million customers in Kowloon and the New Territories (including Lantau, and most of the other outlying islands), serving over 80% of Hong Kong's population and helping to make the city smarter and greener.

"Citywide use of electricity varies daily," Binnie said. "At noon every day, we try to predict hourly electricity load demand in megawatts starting from midnight for 24 hours so we can generate the optimal amount of electricity to ensure customer satisfaction.

"Accurate forecasting and optimization mean we can avoid generating too much or too little energy for users."



Credit: CLP Power Hong Kong Limited

Alumnus Binnie Yiu at HKUST, and (below, left) with the University's former Dean of Engineering Prof. Tim Cheng, now Vice-President for Research and Development, and (below, right) Strathclyde University Principal and Vice-Chancellor Prof. Sir Jim McDonald.

A lifelong learner, Binnie received a BEng in Mechanical Engineering at Hong Kong Polytechnic University in 2010, then worked as an acoustic consultant for six years. Unsure this was right career direction and always keen on mathematical theory and applications, he then undertook an MSc in Mathematics at the Chinese University of Hong Kong. He joined CLP in 2018 as a procurement officer, continuing to broaden his knowledge to artificial intelligence through self-learning and online research, ahead of applying for the dual master's degree program.

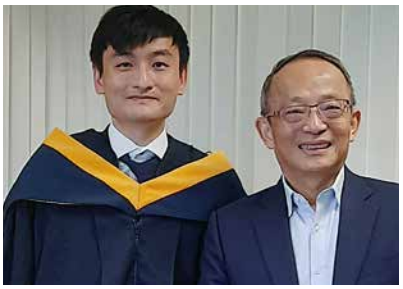
In devising the model for his MPhil thesis, Binnie was supervised and inspired by Prof. ZHANG Tong, Chair Professor of Mathematics and Computer Science & Engineering at HKUST as well as CLP industry supervisor Dr. LEE Cheuk-Wing. Meanwhile, he gained additional practical insights from his online distance learning degree courses at Strathclyde, which is renowned for its industry-based expertise in electricity and power. These included power system fundamentals and renewable energy, among others.

In his thesis, Binnie advocated combining Prof. Zhang's Regularized Greedy Forest (RGF) algorithm, which employs a tree-based machine learning model to form the decision forest, together with two gradient boosting models (XGBoost and LightGBM), creating an ensemble model that delivered improved stability and accuracy.

On the application front, during his studies he was transferred to work as an engineer in the condition monitoring team in CLP's Technical Services Department, using temperature and heat indexes from three Hong Kong Observatory weather stations as input for his model. In 2021, together with CLP's System Operation Department, Binnie started to develop, test, and implement the ensemble model. By early 2022, they had successfully introduced the model to CLP's daily operations. It is now producing forecasts that enable system operators to effectively manage demand responses, optimize generation resources, and simplify and facilitate operational planning decisions. Further benefits include enhancement of equipment servicing decision-making while ensuring sufficient energy supply to customers, he noted.

On the sustainable development front, better system forecasting means fuel is saved, assisting decarbonization. Binnie also hopes that the model's use can eventually be extended from system operations to circuit and consumer levels, widening its reach and encouraging further smart energy use.

To complete his dual degrees in less than three years while working full-time, Binnie balanced his time by setting priorities while fitting sports activities in between to release stress and keep himself on an even keel. His motivation comes from his belief that you should continuously seek to improve yourself and do your best – and from his engineer father, whom he considers to be a role model.



Looking to the future, he would like to keep focusing on both his career and research on machine learning, finding his greatest rewards in creating things that work well. "For me, it's not about studying for studying's sake. I am also committed to industry. By combining the theoretical and practical, that's how we can really make an impact." Given this outlook, it appears Binnie will soon be adding to his collection of firsts.

* Graduates will be awarded a HKUST MPhil degree in one of these disciplines depending on their academic pathway and thesis project: Chemical and Biomolecular Engineering, Civil Engineering, Computer Science and Engineering, Electronic and Computer Engineering, or Mechanical Engineering.

Learning about life as an 'ingénieur'

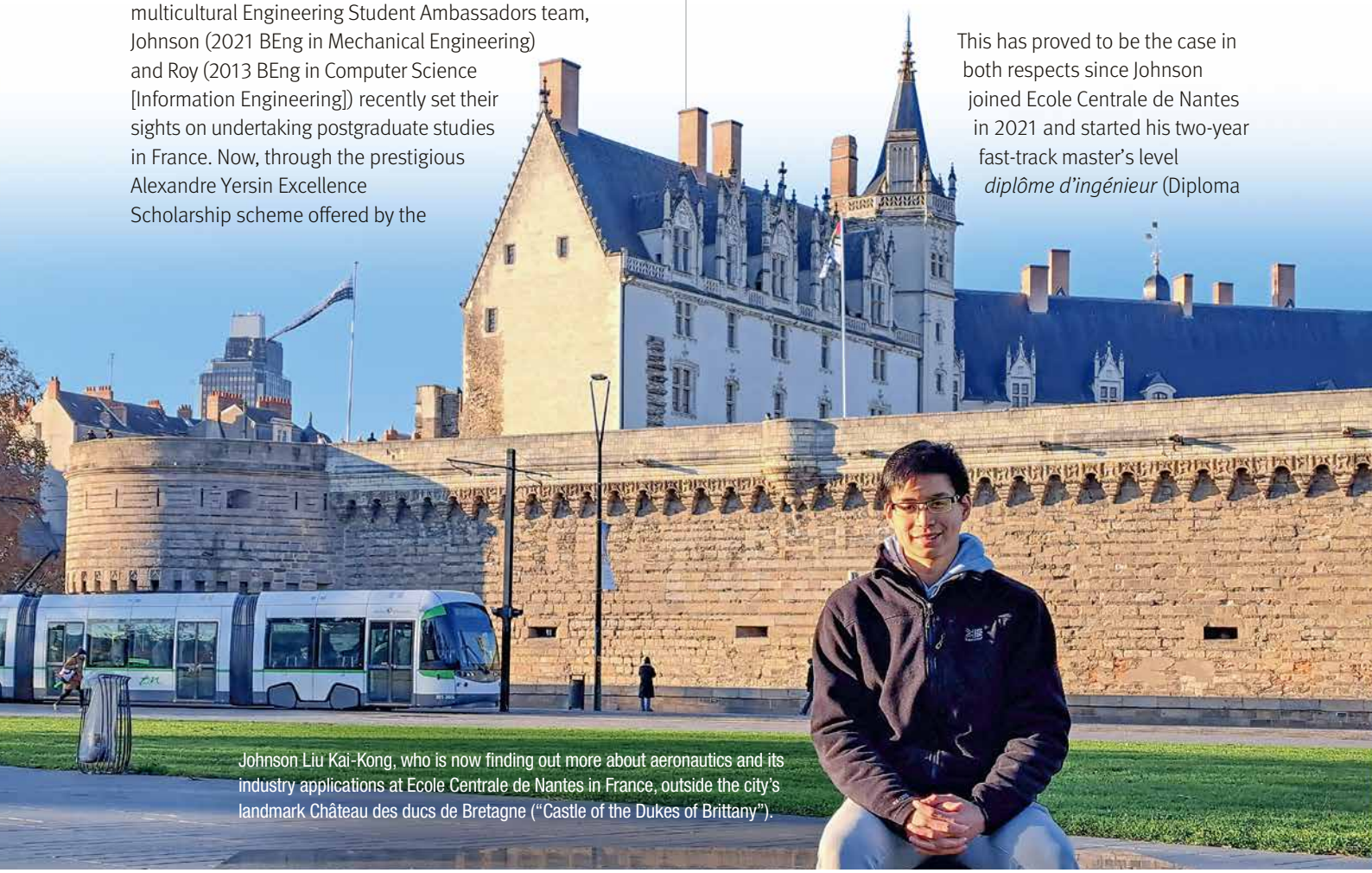
With their HKUST adaptability, two School of Engineering alumni recipients of an eminent French master's degree scholarship scheme are relishing the novel insights into engineering careers and approaches to living they are gaining in the *République Française*

The eye-opening exposure to students from parts of the world and backgrounds is a key feature of School of Engineering (SENG) life and can leave a lasting openness to diverse ideas and ways of life. Ask alumni Johnson LIU Kai-Kong and Roy CHUNG Ming-Hin. From cohorts eight years apart but both steeped in expansive perspectives from their days leading the School's multicultural Engineering Student Ambassadors team, Johnson (2021 BEng in Mechanical Engineering) and Roy (2013 BEng in Computer Science [Information Engineering]) recently set their sights on undertaking postgraduate studies in France. Now, through the prestigious Alexandre Yersin Excellence Scholarship scheme offered by the Consulate General of France in Hong Kong and Macau, the two Hong Kong-born graduates are living their dream at *grandes écoles* (highly selective French higher education institutions) in Nantes and Paris respectively.

***"Students in Asia usually dig deep into a major. What is also valued in France is the* ingénieur généraliste"**

With Johnson's passion for aeronautics and France's leading position globally as the base for multinational aerospace corporation Airbus and major jet engine manufacturer Safran, he saw the scholarship as a great way to build on the knowledge he had acquired at HKUST by finding out more about its industrial applications. He also felt it would be a cultural adventure.

This has proved to be the case in both respects since Johnson joined Ecole Centrale de Nantes in 2021 and started his two-year fast-track master's level *diplôme d'ingénieur* (Diploma



Johnson Liu Kai-Kong, who is now finding out more about aeronautics and its industry applications at Ecole Centrale de Nantes in France, outside the city's landmark Château des ducs de Bretagne ("Castle of the Dukes of Brittany").

Taking a break from the workplace, Roy Chung Ming-Hin is enjoying being a student at ESCP Business School in Paris, where he is updating his knowledge in big data and business analytics.

in Engineering). The intensive program involves a general engineering curriculum in English in the first year and a specialization undertaken in French in the second year. He will thus graduate with a French diploma (rather than an international one), which will position him well for the job market there.

It has been demanding, requiring technical know-how in data science, machine learning, C++ programming, among others, and French. However, Johnson believes he has been well prepared for testing environments by HKUST's drive for high performance and his experiences as an Engineering Student Ambassador, which taught him how to build connections with people of all ages and backgrounds and "present myself in ways that best fit a circumstance".

In France, he has tackled and succeeded in taking highly difficult mathematics classes in relation to engineering. One class on propulsive systems in aeronautics has been taught by a senior engineer at Safran. He is gaining further understanding of industry practices through case studies, internship, and a site visit to Airbus. "Students in Asia usually dig deep into a major," Johnson pointed out. "What is also valued in France is an engineer equipped with necessary skills in multiple domains, the *ingénieur généraliste*."

In addition, Johnson's proactive approach has seen him step well beyond the lecture hall during his time in France. He has taken the opportunity to try out horse riding and boxing, join a choir, and participate in the international students club. Alongside, he has "invested a lot of time" in improving his French, making impressive progress which he credits to the HKUST environment and in particular the SENG ambassador scheme with its emphasis on being proactive, hardworking, and reaching out to talk to people. This has prepared him for his second-year studies and greater integration into the community, while enabling him to share more about Hong Kong with the people he meets.

Meanwhile, Roy, having established a career in UX design at companies such as Microsoft and DBS, recently found himself seeking to widen his capabilities by updating his data literacy in readiness to move to the next career level. Thriving in new situations and able to present himself and his ideas with greater resonance following his undergraduate days and time as a student ambassador at SENG, Roy discovered France was home to some of the world's top programs in the data science field. He decided to take a break from the workplace, and applied for the Yersin scholarship in 2021.

He is now a Master of Science in Big Data and Business Analytics student at ESCP Business School, based in Paris but sometimes visiting the school's campuses in other major cities in Europe. The course is enabling him to take on board programming languages useful for data analysis and machine learning, such as Python, R, and SQL, and discover how businesses in Europe are transforming themselves in the big data era. Moreover, in his first semester, Roy became part of a winning hackathon team, creating a natural language processing solution for a US-based company to analyze public sentiment, with a proposal for action based on social media data insights.

In his first semester, Roy became part of a winning hackathon team, creating a natural language processing solution for a US-based company

This achievement, along with positive feedback from the company, has given him confidence that he is heading "in the right direction in my career". Residing in France has also generated fresh perspectives on dealing with the "new normal" despite initial worries about coping with student life during the on-going COVID global health challenge. In fact, the new normal has provided both the topic for Roy's thesis on the use of data to refine remote working in post-pandemic times and an appreciation of how people in France have upheld their quality of life amid the health crisis through their attitude of "living fully", he noted.

Both alumni felt that their years at HKUST had set them on their way to coping with future challenges, moving forward in life, and being willing to grasp opportunities – such as studying in France. "My advice to current students is to enrich your life experiences and expand your horizons," Roy said. "They will become a great source of creative inspiration in the years to come."

Faculty

External honors

Prof. Khaled B. LETAIEF, New Bright Professor of Engineering and Chair Professor of Electronic and Computer Engineering, received an Honorary Doctorate in Engineering from the University of Johannesburg, South Africa. He has also become the first person in Hong Kong to receive the Institute of Electrical and Electronics Engineers (IEEE) Communications Society Edwin Howard Armstrong Achievement Award. (Photo: University of Johannesburg)

Prof. GUO Yike (left), HKUST Provost and Chair Professor of Computer Science and Engineering, **Prof. CHEUNG Shing-Chi** (center), Computer Science and Engineering, and **Prof. SHI Ling** (right), Electronic and Computer Engineering, have become 2023 IEEE Fellows, bringing the total number among School of Engineering faculty members to 44.

Prof. ZHANG Limin, Head and Chair Professor of Civil and Environmental Engineering, has been recognized with the Ralph B. Peck Award 2023 by the American Society of Civil Engineers.

Prof. Vincent LAU (left) and **Prof. Ross MURCH** (right), both Chair Professors of Electronic and Computer Engineering, were elected 2022 Fellows of the Hong Kong Academy of Engineering Sciences.

Prof. FAN Zhiyong, Electronic & Computer Engineering and Chemical & Biological Engineering, received an Xplorer Prize 2022 for his work on advanced interdisciplinary studies. The annual awards are supported by Tencent Foundation. He was named the laureate in the new materials and new energy field in the inaugural BOCHK Science and Technology Innovation Prize. Prof. Fan has also been elected a 2023 Fellow of Optica.

Prof. Larry LI (left) and **Prof. YU Hongyu** (right), both Mechanical and Aerospace Engineering, have been elected Fellows of the Royal Aeronautical Society.

Prof. WANG Zhe, Civil and Environmental Engineering, together with his team, received a Gold Award in the academic group of the Global AI Challenge for Building E&M Facilities – AI Competition. In the same competition, Prof. Wang and the team also won the Huawei Most Innovative Use of Data Award and Best Use of Tencent Cloud Award.

Prof. Wei SHYY, former HKUST President and now Professor Emeritus of Mechanical and Aerospace Engineering, has been made an Officer in the National Order of the Legion of Honor by the French government.

Prof. ZHOU Xiaofang (left), Head and Chair Professor of Computer Science and Engineering, and **Prof. WANG Jiguang** (right), Life Science and Chemical & Biological Engineering, have been honored with HKUST named professorships. Prof. Zhou has been named Otto Poon Professor of Engineering, while Prof. Wang has been appointed Padma Harilela Associate Professor of Life Science.

Associate Dean of Engineering (Undergraduate Studies) **Prof. WANG Yu-Hsing**, Civil and Environmental Engineering, has been elected a Fellow of the American Society of Civil Engineers.

Prof. FU Lin, Mechanical & Aerospace Engineering and Mathematics, received an Early Career Award 2022/23 from the Research Grants Council of Hong Kong for his project to advance flow prediction technology in aerospace engineering.

Prof. Anthony LEUNG, Civil and Environmental Engineering, received the Outstanding Young Geotechnical Engineer Award from the International Society for Soil Mechanics and Geotechnical Engineering.

HKUST

Prof. Desmond TSOI, Computer Science and Engineering, was awarded the prestigious Michael G. Gale Medal for Distinguished Teaching for 2022. Prof. Tsoi was also one of four faculty members to receive School of Engineering Teaching Excellence Appreciation Awards 2021-22, being selected for the top accolade, the Distinguished Teaching Award, for the second time. **Prof. Winnie LEUNG**, Integrative Systems and Design, **Prof. Larry LI**, Mechanical and Aerospace Engineering, and **Prof. Dimitris PAPADOPOULOS**, Computer Science and Engineering, received Teaching Awards.

Three engineering faculty and staff were recognized in the HKUST Common Core Teaching Excellence Award 2021 for designing and teaching exemplary common core courses. **Prof. Kenneth LEUNG**, Computer Science and Engineering, received the award for COMP 2711 Discrete Mathematical Tools for Computer Science, while **Mr. Malinda ABEYNAYAKE** and **Mr. Joel YU** (pictured together), Student Innovation for Global Health Technology (SIGHT) team, received an Honorary Mention for ENGG 1300 Design Thinking for Health Innovation.

Students & Alumni

Computer Science and Engineering PhD student **LI Haotian** was named a 2022 Microsoft Research Asia Fellow, the only awardee from a Hong Kong university among 12 selected. His research interests include data visualization, visual analytics, and human-computer interaction. The Fellowship Program seeks to help students realize their potential in research through mentorship, research, networking, and academic opportunities, including an internship at Microsoft Research Asia in Beijing.

Dr. ZHENG Zheyang (2021 PhD in Electronic and Computer Engineering) received the School of Engineering PhD Research Excellence Award 2021-22. Zheyang, now Research Assistant Professor at HKUST, focuses on wide-bandgap semiconductor electronic devices and systems. He joined the University in 2016 as a recipient of a prestigious Hong Kong PhD Fellowship.

Civil and Environmental Engineering postgraduate students **LEUNG Pak-Him** (back row, first left) and **WONG Kok-Yiu** (front row, right) (both Class of 2022) took home the championship at the HKUST-Sino One Million Dollar Entrepreneurship Competition 2022 as part of the platinum award-winning AutoSafe team, advised by **Prof. Jack CHENG** (back row, second right). The team's invention centered on a new artificial intelligence-based system to monitor construction site safety. Two other School of Engineering teams won the gold and silver awards. A total of 175 teams formed by HKUST faculty, students and alumni, as well as participants from other local and overseas institutions, took part in the 2022 contest.

Dr. CHEN Huangxun (left) (2020 PhD in Computer Science and Engineering), **Dr. CHEN Li** (center) (2018 PhD in Computer Science and Engineering, 2013 MPhil in Electronic and Computer Engineering, 2011 BEng in Electronic Engineering), and **Dr. WANG Wei** (right) (2004 PhD in Computer Science) received the Best Paper Award at ACM SIGCOMM 2022. They earned the accolade for their work on "Software-Defined Network Assimilation: Bridging the Last Mile Towards Centralized Network Configuration Management with NAssim".

Philip YEUNG Wai-Lok (2015 BEng in Logistics Management and Engineering) won the CILT International Young Achiever of the Year 2022. Organized by the Chartered Institute of Logistics and Transport (CILT), the global award is held annually to recognize a young professional who has made a significant contribution to logistics and transport. Philip was nominated to represent Hong Kong after winning the CILTHK Young Achiever Award 2020.

Dr. WU Kaishun (2011 PhD in Computer Science and Engineering) has been named a 2023 IEEE Fellow for contributions to wireless sensing and ubiquitous computing. He is now Associate Vice-President for Research at HKUST(GZ). Prior to his current appointment, he was Professor and Director of Guangdong Provincial Wireless Big Data and Future Network Engineering Center at Shenzhen University.

New appointments

Administrative

Prof. GUO Yike
Appointed Provost and Chair Professor of Department of Computer Science and Engineering

Prof. Hong K. LO
Appointed Dean of Engineering
Chair Professor, Civil and Environmental Engineering

Prof. ZHOU Xiaofang
Appointed Head of Department of Computer Science and Engineering
Chair Professor, Computer Science and Engineering

Prof. SUN Qingping
Appointed Head of Department of Mechanical and Aerospace Engineering
Professor, Mechanical and Aerospace Engineering

Prof. Bertram SHI
Appointed Special Advisor to Vice-President for Research and Development
Professor, Electronic and Computer Engineering

Prof. YANG Jinglei
Appointed General Director of HKUST Shenzhen Research Institute, General Director of HKUST Shenzhen-Hong Kong Collaborative Innovation Research Institute, and General Manager of HKUST R and D Corporation (Shenzhen) Limited
Professor, Mechanical and Aerospace Engineering

Prof. ZHANG Fumin
Appointed Director of HKUST Cheng Kar-Shun Robotics Institute and Chair Professor of Department of Electronic and Computer Engineering and Department of Mechanical and Aerospace Engineering

Faculty

Prof. JIANG Jiashuo
Assistant Professor, Industrial Engineering and Decision Analytics
PhD – New York University

Prof. LAI Yong
Assistant Professor, Chemical and Biological Engineering
PhD – The University of Hong Kong

Dr. Jac LEUNG Ka-Lok
Lecturer, Integrative Systems and Design
EdD – The University of Hong Kong

Prof. LIN Yen-Hung
Assistant Professor, Electronic and Computer Engineering
PhD – Imperial College London

Prof. LU Yanglong
Assistant Professor, Mechanical and Aerospace Engineering
PhD – The Georgia Institute of Technology

Prof. Hnin Yin Yin NYEIN
Assistant Professor, Chemical and Biological Engineering
PhD – University of California, Berkeley

Prof. PAN Yuxin
Assistant Professor, Civil and Environmental Engineering
PhD – The University of British Columbia

Prof. Rob SCHARFF
Assistant Professor, Integrative Systems and Design
PhD – Delft University of Technology

Prof. SHEN Jiasi
Assistant Professor, Computer Science and Engineering
PhD – Massachusetts Institute of Technology

Prof. SHEN Yajing
Associate Professor, Electronic and Computer Engineering
PhD – Nagoya University

Prof. SU Hui
Professor, Civil and Environmental Engineering
PhD – University of Washington

Prof. WONG Man-Hoi
Associate Professor, Electronic and Computer Engineering
PhD – University of California, Santa Barbara

Prof. XIANG Changying
Assistant Professor, Integrative Systems and Design
PhD – Norwegian University of Science and Technology

Prof. XIE Zhiyao
Assistant Professor, Electronic and Computer Engineering
PhD – Duke University

Prof. ZHAN Ruohan
Assistant Professor, Industrial Engineering and Decision Analytics
PhD – Stanford University

Prof. ZHANG Fan
Assistant Professor, Civil and Environmental Engineering
PhD – The Chinese University of Hong Kong

Prof. ZHENG Qiye
Assistant Professor, Mechanical and Aerospace Engineering
PhD – University of Illinois Urbana-Champaign

Transforming research into social impact

HKUST Industry Engagement Day was successfully held at HKUST's Shaw Auditorium and Jockey Club Institute for Advanced Study in November 2022. The event brought together University innovators with diverse sectors of the community to explore opportunities and open pathways for University-industry collaborations that can transfer campus research and development to impactful applications in society and spur Hong Kong's drive to become a global innovation and technology hub.

The all-day event showcased over 30 HKUST technologies, including many from the School of Engineering, and drew hundreds of potential investors, executives, entrepreneurs, government officials, representatives of the European Union and different consulates-general, members of business chambers, and the academic and technology sectors. Research areas covered sustainability and smart living; medical and biotechnology; big data, fintech, AI and robotics; and semiconductors, sensors and microelectronics.

Prof. SUN Dong, Secretary for Innovation, Technology and Industry, HKSAR Government, HKUST President Prof. Nancy IP, and Vice-President for Research and Development Prof. Tim CHENG spoke at the event. Activities included a symposium, seminars, innovation showcases, and guided tours.

With HKUST's entrepreneurial culture and strong network of over 600 local, regional and international industrial and government partners, the University community has helped foster over 1,600 active start-up companies, including nine unicorns and nine initial public offering (IPO) companies, resulting in economic impact of over HK$400 billion.

Novel sensors monitoring indoor air quality (main picture); water sampling utilizing a hexacopter drone (above, top); human-computer interaction for robot sensing and medical evaluation (above).