Asia's First Transnational
R&D Consortium on
AI Chip Design

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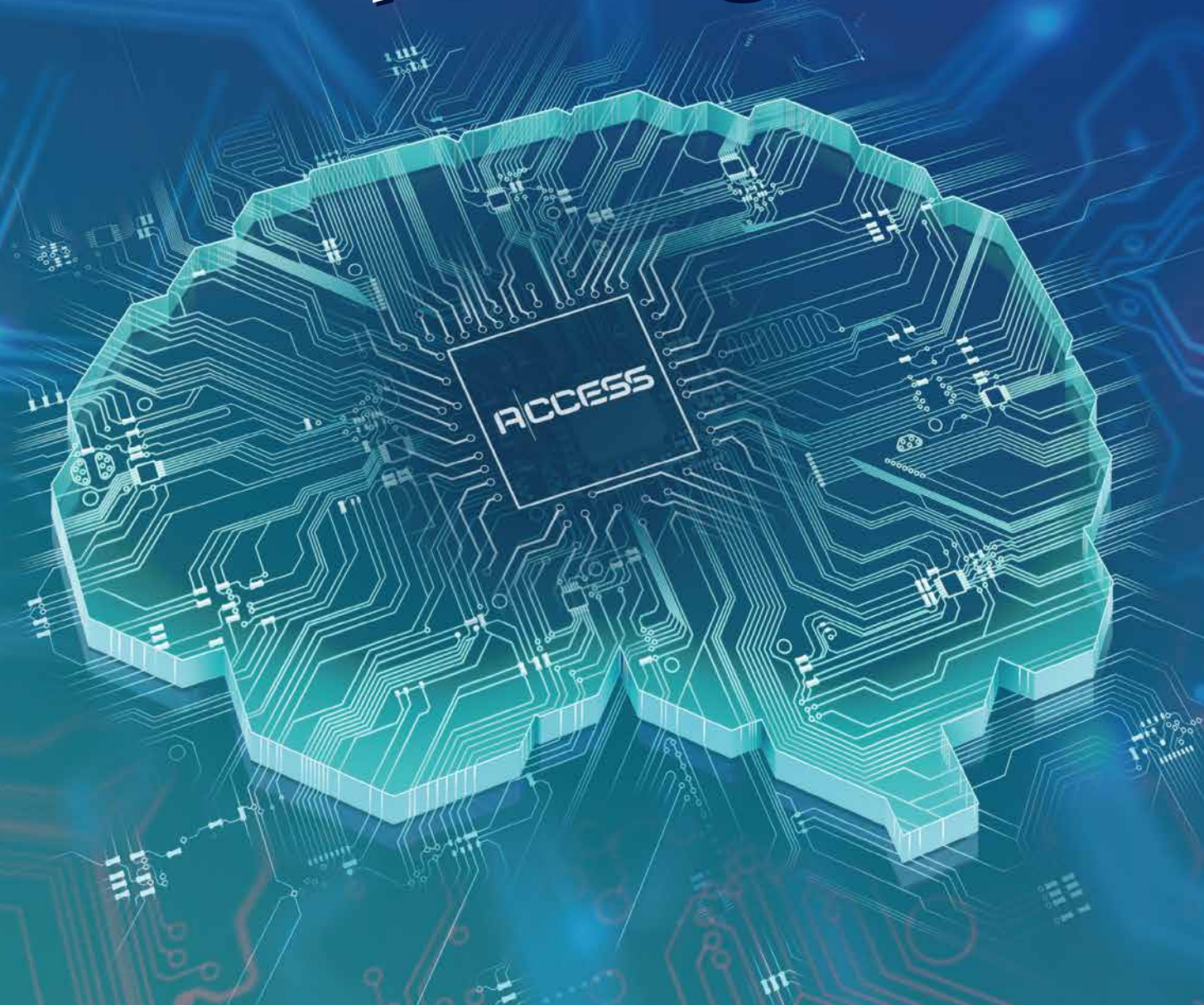
香港科技大學
THE HONG KONG
UNIVERSITY OF SCIENCE
AND TECHNOLOGY

工學院
SCHOOL OF
ENGINEERING

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成就未來 齊放異彩
TOGETHER
WE EMPOWER

CONTENTS

An innovation powerhouse

This will be my final *In Focus* column as Dean before taking up the post of Vice-President for Research and Development in April 2022 (see also P4). Looking back, it has been an extraordinary six years. Situations locally and globally have tested me, the School, and the University. The social incidents and COVID-19 have all had to be managed to the best of our abilities and I am very proud to have been part of HKUST's collegiate team during such times. It has also made my tenure one of great personal reflection, self-learning, and a few more gray hairs!

Despite these unanticipated challenges, goals set on joining the School of Engineering (SENG) have kept moving ahead, in particular extending our multidisciplinary capabilities. Given that solutions to complex major global challenges such as climate change and aging populations lie beyond a single discipline, and emerging fields often cross traditional boundaries, it has been essential to do so.

Thus, in recent years, SENG faculty have led the establishment of significant multidisciplinary institutes at the University, such as the Cheng Kar-Shun Robotics Institute, Big Data Institute, Energy Institute, and GREAT Smart Cities Institute, and joint labs with industry, including the HKUST-Bright Dream Robotics Joint Research Institute and HKUST-WeBank Joint Laboratory. The School has also engaged in major collaborations with other top local and global universities, including the recent AI Chip Center for Emerging Smart Systems (see also P12-15). These endeavors have widened and deepened our R&D capabilities and social impact, producing successful entrepreneurial graduates and seeing SENG faculty and students involved in more than 80% of the University's knowledge transfer activities.

Meanwhile, for our undergraduates, we have worked hard to evolve multidisciplinary programs that are opening up minds and community recognition regarding the immense career potential of engineering and innovation today and tomorrow. We have launched degrees in key emerging areas, such as sustainable energy engineering and data science & technology, and introduced an extended major embracing AI or digital media and arts, among other initiatives. In addition, we have adopted innovative engineering pedagogies and creative online learning to equip our graduates with the flexibility, curiosity, and enquiring minds to embrace the rapidly evolving future as well as the core engineering skills they require.

The future is set to be equally bright. The School has already played a major role in the cutting-edge cross-disciplinary approach of the new HKUST(GZ), with these close ties set to deepen when the campus in Nansha opens this September. Burgeoning opportunities in the Greater Bay Area will provide further scope for development as a dynamic engine of innovation. SENG will also continue to seek top faculty, researchers, and students from around the world, adding further vision and perspectives to our community and that of the wider University. This is why I am confident that in the next six years, the School will keep soaring to fresh heights, not only as a reputable, highly ranked engineering hub, but also as an innovation powerhouse of technology.

Kwang-Ting Cheng

Prof. Tim CHENG Kwang-Ting
Dean of Engineering

Moving on to VP role

Dean of Engineering Prof. Tim CHENG Kwang-Ting has been appointed Vice-President for Research and Development (VPRD), effective April 1, 2022.

Prof. Cheng, also a Chair Professor of Electronic & Computer Engineering and Computer Science & Engineering, is a renowned scholar in electronic design, design automation, and computer vision. He has also taken up numerous academic leadership roles as well as providing professional advice and service to the eminent global Institute of Electrical and Electronics Engineers (IEEE).

After graduating with a PhD in Electrical Engineering and Computer Sciences at the University of California, Berkeley, Prof. Cheng worked at Bell Laboratories in New Jersey for five years, followed by more than 20 years at the University of California, Santa Barbara. He joined HKUST as Dean in 2016.

In his new role as VPRD, Prof. Cheng said he would endeavor to add to HKUST's research and development (R&D) activities through enhanced collaboration between the University's four Schools of Engineering, Science, Business and Management, and Humanities and Social Science, as well as the Interdisciplinary Programs Office; seize Greater Bay Area opportunities; further strengthen

Prof. Tim Cheng Kwang-Ting: HKUST's new Vice-President for Research and Development.

international collaborations; and deepen industrial cooperation and knowledge transfer.

In particular, he hopes to help the University extend from a research trailblazer into a dynamo for impact through closer integration of research and development. "These two segments cover the full spectrum from basic research to impact. The University has made good progress at both ends and the next phase is to really integrate these two into a robust pipeline," he said. "I am looking forward to contributing to this change at HKUST."

HKUST(GZ) takes shape

Construction of all 55 buildings in the first phase of HKUST's Guangzhou campus is due to be completed by March 2022, with façades and interiors next to get underway. HKUST(GZ) and its world-leading interdisciplinary approach and infrastructure will work in synergy with the Clear Water Bay campus to create a complete innovation

and technology ecosystem, from education and research to applications and social impact. The 110-hectare HKUST(GZ), located in Qingsheng, Nansha, is nearly double the size of the 60-hectare Clear Water Bay campus.

The additional space and resources will create a significant opportunity for HKUST to advance emerging research directions and foster greater University-industry collaboration in the Greater Bay Area. Rather than schools or departments, HKUST(GZ) will operate under four interconnected multidisciplinary hubs (function, information, systems, society). As with the Hong Kong campus, HKUST(GZ) is aiming to become "net-zero" in carbon emissions. It is scheduled to open in September 2022.

The new campus is seeking to grow to 4,000 postgraduates and 400 faculty within the first five years, and undergraduates starting from 2023.

HKUST's new campus in Guangzhou is set to open this September.

SENG has shown its on-going attainment in a demanding local research assessment exercise and global rankings.

Driving engineering higher

The School of Engineering (SENG)'s on-going high performance has attained significant recognition in two diverse quality indicators.

The School achieved outstanding results in multiple disciplines in the Research Assessment Exercise (RAE) 2020, the most recent of these demanding exercises carried out periodically by Hong Kong's University Grants Committee. The RAE assesses the performance of the city's eight publicly funded universities to encourage world-class research and drive excellence, using international benchmarks to delineate universities' areas of relative strength.

Results for RAE 2020, released in 2021, showed HKUST ranked first for 4* (world leading) research activities in three out of five Units of Assessment involving engineering disciplines: chemical engineering, biomedical engineering, other technologies & marine engineering; civil engineering & building technology; and electrical & electronic engineering. In the four broader-based Panels related to engineering, the School led the way in research work assessed to be 4* in built environment and electrical & electronic engineering.

In addition, 100% of SENG's 12 research impact cases received either 4* (outstanding) or 3* (considerable) impact in reach and significance, an indication of the School's endeavors to transfer its research into innovation in society. Examples included a smart antimicrobial coating for surface disinfection and air filtration, a technology that has since gone on to play a major part in the community's battle against COVID-19, as well as green technologies for mitigating landslide risks.

Around 160 SENG academic staff were involved in submissions for RAE 2020. In the University overall, 446 eligible staff took part in 17 Units of Assessment involving nine Panels. A total of 35 impact cases were submitted.

Global campus recognized

2022 got off to a flying start in January, with HKUST named the third most international university in a ranking published by *Times Higher Education*. The World's Most International Universities list looked at the proportion of international staff and students, co-authored publications, and reputation. At HKUST, more than one-third of the student body is considered international, with around 60 nationalities represented. Some 80% of faculty come from outside Hong Kong, while the University's network of over 310 institutional academic and research partners provide numerous exchange, research, and internship opportunities. More than 45% of students undertake an exchange and around 70% take part in regional and global internships.

Later the same year, in the *Times Higher Education* World University Rankings 2022 by Subject, HKUST was globally ranked No.26 in computer science, a jump of five places from the previous year, and No.28 in engineering. In Hong Kong, the University remained at the forefront in these subject rankings, achieving the No.1 spot in computer science for the sixth year in a row and in engineering for the eleventh consecutive year.

From left: Prof. Shao Minhua, Prof. Chen Guanghao, and Prof. Francesco Ciucci, who are working respectively toward high-performance hydrogen fuel cells, low-carbon waste management technologies, and cost-effective green hydrogen production.

Assisting Hong Kong go green

Three School of Engineering academics have secured over HK$18 million in total in the first round of funding from the HK$200 million Green Tech Fund. The fund, set up by the Hong Kong government in 2020, assists R&D projects that can help Hong Kong decarbonize and enhance environmental protection as the city seeks to achieve carbon neutrality before 2050.

Nearly HK$9 million was awarded to Prof. SHAO Minhua, Director of the HKUST Energy Institute, to develop high-performance and long-life hydrogen fuel cell stacks, the largest amount of funding among the 14 projects supported so far. The fund received over 190 applications in the first round. Prof. Shao, Chemical and Biological Engineering, and his team are setting out to develop low platinum catalysts and membrane electrode assemblies that can be integrated into fuel cell stacks, suitable for wide applications related to stationary power plants and electric vehicles. The team is collaborating with Towngas and other industry partners locally and in Mainland China.

Prof. Francesco CIUCCI, Mechanical and Aerospace Engineering, received around HK$3.2 million to devise an innovative active flow membraneless electrolyzer to boost green hydrogen production cost-effectiveness. Prof. Ciucci's project aims to scale up the current prototype stack and demonstrate it is cost-competitive compared to CO_2-emitting gray hydrogen.

Water pollution control expert Chair Professor CHEN Guanghao, Civil and Environmental Engineering, was awarded around HK$6.7 million to explore low-carbon waste management technologies that can make hard-to-treat black water from a landfill site co-treatable with a downstream wastewater treatment plant, minimizing costs and space.

Heading for a net-zero carbon campus

HKUST has established a Sustainability/Net-Zero Office to drive the University's goal to become a sustainability leader across the region and beyond. The office also aims to be a resource for government and businesses in addressing climate change, water scarcity, and building of a circular economy, among other major challenges. The initial assignment for the office is to create a roadmap for the University to become a net-zero carbon campus before 2050. Mr. Davis BOOKHART, formerly Head of the Sustainability Unit in HKUST's Health, Safety and Environment Office, is now serving as the office's Director.

App helps to find dementia wanderers

In a socially impactful development, Prof. Gary CHAN, Computer Science and Engineering, and his research team have devised a novel mobile app that is helping to find missing dementia patients in Hong Kong through crowdsourcing and Bluetooth positioning technology.

Prof. Chan, who was responsible for developing the original StayHomeSafe geo-fencing technology for COVID-19 home quarantine enforcement in the city in 2020, created and launched the Dementia's Secret Angel app, together with a low-cost iBeacon tag carried by people with dementia, through the Jockey Club Caring Communities for Dementia Campaign (JC CCDC) later the same year.

The School of Engineering technology assists family members and caregivers to efficiently search for dementia patients when they are lost. In a survey conducted for JC CCDC, co-organized by the Jockey Club Centre for Positive Ageing and St. James' Settlement, around 30% of 576 caregivers/relatives said that their patients had got lost at some point and almost 85% of these respondents were worried it would happen again.

The app is currently serving more than 2,600 people with dementia and has been downloaded over 30,000 times so far. The Bluetooth tag is similar in size to a HK$5 coin and can last for more than one year without charging. For ease of use, it has also been designed as a card that can be fitted into a wallet and a handle that can be attached to a walking stick.

Members of the public and companies can also lend a hand to help to search for dementia wanderers. The public can download the power-conserving, privacy-preserving app to become secret "Angels", and anonymously share location data through their smartphones when the Bluetooth signal of a wanderer is detected in their neighborhood. Corporations can install Bluetooth signal detectors called "Angel boxes". The technology's cloud-based program is then able to use the GPS signals from the Angels or Angel boxes to search for wanderers. In January 2022, KMB installed Angel boxes at five main bus terminals to extend the technology's reach.

Prof. Gary Chan with his Dementia's Secret Angel app and Bluetooth tag in its portable card format.

Study suggests T cells remain effective against Omicron

A joint study conducted by School of Engineering researchers and the University of Melbourne has found that T cells, one of the body's key defenses against COVID-19, are expected to be effective in mounting an immune response against the Omicron variant. This is despite Omicron's higher number of mutations than other variants.

T cells generated by vaccinations and COVID-19 infections have been shown to be critical in limiting progression to severe disease by eliminating virus-infected cells and helping with other immune system functions.

In the study, the team, which specializes in computational biology/immunology, analyzed over 1,500 fragments of SARS-CoV-2's viral proteins – called epitopes – that T cells have been shown to recognize in recovered COVID-19 patients or after vaccination. The researchers found only

20% of the epitopes showed mutations associated with the Omicron variant. Furthermore, these mutations did not necessarily mean the virus would evade the body's T cells.

The research was published in *Viruses* in January 2022 by then postdoctoral fellow Dr. Syed Faraz AHMED, Prof. Ahmed Abdul QUADEER, both Electronic and Computer Engineering and HKUST PhD graduates, and Prof. Matthew MCKAY, University of Melbourne and previously at HKUST. The work was also featured in multiple local and international news outlets.

Despite being a preliminary study, the team believes the data suggests that T cell responses induced upon COVID-19 infection and vaccination will continue to offer protection against Omicron. Consistent conclusions were reported later by numerous experimental and clinical studies.

Unicorns spotlight entrepreneurship

In the inaugural "Unicorns HK 2021" shortlist, announced recently by the Hong Kong X Foundation, six out of 18 companies were founded or co-founded by faculty or alumni from the School of Engineering .

As unicorns, the 18 unlisted start-ups each have a market value of more than US$1 billion. All the companies were also founded, or incubated/headquartered in Hong Kong, or the founders were Hong Kong residents. Those related to HKUST (see table) focus on AI, robotics, high-end manufacturing, sensors, and autonomous driving.

The unicorns' shortlist was released at the Inno Bay 2021 program, organized by the Foundation and China Global Television Network in November 2021. The event gathered policymakers, entrepreneurs, and technology experts to discuss the further development of innovation and technology in the Greater Bay Area. Prominent speakers included Mrs. Carrie LAM, Chief Executive of the HKSAR Government, and Mr. LEUNG Chun-Ying, Vice-Chairman of the National Committee of the Chinese People's Political Consultative Conference.

The Hong Kong X Foundation was established by Sequoia Capital China, a venture capital fund, in 2016 to foster entrepreneurial culture and support young entrepreneurs in Hong Kong.

Start-up*	HKUST Member(s)	Position in Unicorn
4Paradigm Platform-centric solutions for enterprise-class AI products	DAI Wenyuan *Alumnus* Computer Science and Engineering (PhD)	Founder and CEO
	Prof. YANG Qiang *Faculty* Computer Science and Engineering	Co-founder
CiDi Smart automotive driving for commercial vehicles and logistics modeling	Prof. LI Zexiang *Faculty* Electronic and Computer Engineering	Co-founder
DJI Global consumer drones and aerial imaging technology	Frank WANG Tao *Alumnus* Electronic and Computer Engineering (MPhil & BEng)	Founder, CEO, and CTO
Googol Technology Innovative motion controls for manufacturing automation	Prof. LI Zexiang *Faculty* Electronic and Computer Engineering	Co-founder and Chairman
SmartMore Computer vision technology for intelligent manufacturing and video-enhancement services	JIA Jiaya *Alumnus* Computer Science and Engineering (PhD)	Founder and Chairman
SmartSens Technology High-performance CMOS image sensor chip design	XU Chen *Alumnus* Electronic and Computer Engineering (PhD & MPhil)	Founder and CEO

* The other companies on the Unicorns HK 2021 shortlist were: AfterShip, Airwallex, EcoFlow, Geek+, GeneHarbor, GOGOX, Hai Robotics, Insilico Medicine, KLOOK, Lalamove, SenseTime, and WeLab Bank.

Above: Tseung Kwan O Government Secondary School students construct a soccer robot. Below: Other participants go into action at a pilot workshop.

Robotic goals

The Academy for Bright Future Young Engineers, under the School of Engineering (SENG), held two well-received soccer robot workshops for secondary school students in January 2022 as part of its new Bright Future Cup – Soccer Robot Competition.

At the workshops, students from Tseung Kwan O Government Secondary School set science, technology, engineering, and mathematics (STEM) knowledge and skills to work to devise game-playing robots in HKUST's Undergraduate Student-initiated Experiential Learning Lab (USEL Lab). Last summer, pilot workshops involving junior and senior secondary school students from a total of seven schools were successfully held. A grand final bringing together teams from various schools is targeted to take place in July 2022.

In 2021, Prof. Roy CHUNG, Founder of the Bright Future Charitable Foundation, donated a further HK$5 million for the Academy's daily operations and soccer robot contest. Among its goals, the Academy seeks to inspire young people's interest in engineering and build connections with SENG students.

Talking to the taikonauts

A Mechanical and Aerospace Engineering fresh graduate had a truly space-age experience last September when he served as an emcee for the real-time video dialogue between three taikonauts orbiting the Earth in China's Tiangong space station and Hong Kong young people.

Passionate about space innovation and engineering from an early age, Marco CLARK (2021 BEng in Aerospace Engineering) was thrilled to have the opportunity to take part in the call and seminar alongside a professional media anchor at the Hong Kong Convention and Exhibition Centre.

During the otherworldly exchange, NIE Haisheng, LIU Boming, and TANG Hongbo answered students' questions on experiments being carried out and daily life at the space station. In addition, students could converse with space engineers and experts in Beijing, including China's first taikonaut YANG Liwei.

Top officials at the special event, arranged by the central government, included Mrs. Carrie LAM, Chief Executive of the HKSAR Government, and Dr. TAN Tieniu, Deputy Director of the Liaison Office of the Central People's Government in the HKSAR. Close to 300 students, teachers, scientists, and academics also attended.

While Marco is fluent in Putonghua (his alumna mother is Chinese and his father from the US) and engaged in hours of practising, he still had to battle initial nerves during his inaugural stint as an emcee. That was until excitement at being up close with the taikonauts took over. Indeed, the

School of Engineering fresh graduate Marco Clark and media anchor Zhu Dan hosting the extraterrestrial encounter.

whole event was an "incredible" moment for all students studying the field and working to become future aerospace scientists or taikonauts, he told reporters.

The young engineer is now continuing to enhance his communication skills at BAH Partners, a niche head-hunting firm specializing in technology recruitment, and by serving as a Head Engineering Student Ambassador for 2021-22. He sees such capabilities as a key factor to attaining top-flight positions and responsibilities.

In the longer term, rather than heading into space himself, Marco wants to use his strengths in engineering, technology, and presentation to advance the aerospace industry and space exploration through innovation, with the nanosatellite sector of particular interest. "In this way, I really hope I can bring about many out-of-this-world experiences and achievements for others," he said.

Gaining the confidence to take opportunities

As an Associate Dean, Prof. Mow Wai-Ho is setting out to motivate students to take a broader view of learning and life

Prof. MOW Wai-Ho, appointed Associate Dean of Engineering (Undergraduate Studies) in the summer of 2021, is a firm believer in the benefits of wide-ranging exposure to different settings and perspectives to deepen all-round understanding and capabilities – and is keen to motivate School of Engineering (SENG) students to do the same in his new role.

In particular, he is seeking to motivate students to take advantage of experiential learning, exchange opportunities outside Hong Kong once COVID-19 diminishes, and internships to broaden their horizons and challenge themselves.

"The opportunities are there, but some students may not fully leverage them due to lack of confidence or proactivity," he said. "The more eye-opening experiences you seek, the more capable you will become in managing the ever-changing scenarios in life."

The electronic and computer engineering expert recalled how he was initially more of a mental traveler than geographical explorer, being amazed as science teachers at his high school cracked complex text-based problems with equations and formulae, finally coming up with concise yet profound solutions.

Excelling in mathematics, physics, and interested in electronics, he decided to make electronic engineering his major focus. He undertook undergraduate and postgraduate studies at the Chinese University of Hong Kong, where he completed his PhD in just two years, winning the Best PhD Thesis in Engineering Award, Young Scholar Dissertation Award, and publishing a book on sequence design.

He then began to go global when a Croucher Research Fellowship and Humboldt Research Fellowship enabled him to carry out research at Canada's University of Waterloo and Germany's Technische Universität München (TUM) respectively in his late twenties and early thirties. He went on to teach at Singapore's Nanyang Technological University, before returning to Hong Kong to join the

Prof. Mow Wai-Ho would like undergraduates to seek out eye-opening experiences to build their capabilities.

Department of Electronic and Computer Engineering at HKUST in 2000.

The combination of academic excellence together with local and international insights he acquired are what he is now seeking to encourage in SENG students through his involvement in steering the School's undergraduate curriculum and policies.

Noting that many Hong Kong students and parents are highly pragmatic in their approach to education, he views it as important to avoid being overly focused on "hot" job trends. "In view of the fast-changing world, they should instead build robust fundamental soft and hard skills that are always needed," he said. This would then allow graduates to take advantage of newer opportunities that emerge during their years at university, he added.

The School is also moving toward greater breadth and depth within a discipline to bring greater exposure, and know-how within a field through more flexible program structures and project learning to facilitate students in taking courses that are of the highest interest to them, he said.

As such, he advises that students "seek opportunities one step at a time" to deepen their insights and understanding. "This will take them much further."

Drawing top talent, opening up potential

Helping students to explore interests is a key quest for Associate Dean Prof. Wang Yu-Hsing

Prof. WANG Yu-Hsing sees two important missions ahead as Associate Dean of Engineering (Undergraduate Studies) since January 2022: to recruit high-quality students from around the world and facilitate innovative additions to the curriculum. He is now vigorously pursuing both tasks in synergy with the work of Prof. MOW Wai-Ho, his fellow Associate Dean.

Assisting Prof. Wang in his recruitment endeavors are the School's and HKUST's strong performances as leading learning destinations in international rankings and the diverse student enrichment opportunities available. These activities range from student exchanges and early research programs to experiential learning, mentorship, and counseling services.

A curriculum that is continuously being enhanced is another major advantage, Prof. Wang believes. He is currently assisting full accreditation of undergraduate programs in Sustainable Energy Engineering, Bioengineering, and Decision Analytics. He also notes the 2021 launch of the Engineering with an Extended Major in Artificial Intelligence, where students can undertake studies in AI-related subjects on top of their majors; and the earlier Individualized Interdisciplinary Major, offered by the Interdisciplinary Programs Office, which enables exceptional students to pursue a cross-school, non-traditional program shaped to their specific interests. The latter is the only program of its kind in Greater China. "The academic freedom here ensures that students can choose to work according to their aspirations," Prof. Wang said.

His own aspirations have centered around studying the natural world, a passion since childhood. To do so, he chose geotechnical engineering, a branch of civil engineering, which both fulfilled his parents' expectations and his own interest. Dealing with soil, rocks, earthquakes, landslides, and the natural environment, geotechnical engineering "is not only about the man-made, concrete environment, it is about Mother Nature," he explained.

After receiving bachelor's and master's degrees from National Taiwan University, Prof. Wang undertook PhD studies at Georgia Institute of Technology in the US. He joined HKUST soon after gaining his doctoral degree in 2001.

Prof. Wang Yu-Hsing sees students can work according to their aspirations given the School's many innovative programs and activities.

A two-time awardee of the School's Teaching Excellence Appreciation Award and Residence Master of student halls, Prof. Wang is fully committed to all-round learning and guidance. Such dedication includes actively recruiting undergraduates to the HKUST Data-Enabled Scalable Research Lab he directs to provide early research know-how as well as incubate creative learners.

The Lab is a makerspace that specializes in the geotechnical internet of things, deep learning, and big data analytics, delivering sensors and applications that can advance sustainable city development and assisting numerous government departments. It covers areas such as slope health monitoring and critical infrastructure monitoring. Prof. Wang and his students have also used advanced sensors and AI to monitor the health and stability of trees.

Meanwhile, in his own time, Prof. Wang has documented 63 kinds of birds, numerous plants, and even spotted a barking deer at HKUST's nature-friendly campus, with most discoveries shared on social media.

Such wide-ranging enthusiasms are likewise echoed in his advice to aspiring engineers. "Do not limit your potential," he said. "Be brave and try out all possibilities."

AI chips…
with everything

A new world of mass customization in which everyday devices are enhanced by greater intelligence is set to be fast forwarded through a unique multinational research center, helmed by the head of the School of Engineering

Be it clothes, jewelry, buildings, or hospital beds, the realization of ubiquitous AI applications in society is now moving closer through the groundbreaking work of Asia's first transnational research and development center on AI chip design, led by Dean of Engineering Prof. Tim CHENG Kwang-Ting.

The multidisciplinary AI Chip Center for Emerging Smart Systems (ACCESS) is striving to revolutionize the global AI chip design and talent pipelines. To achieve this, it is bringing together a leading end-to-end R&D consortium of expertise that is driving forward innovation through novel AI chips that improve performance and energy efficiency

Prof. Tim Cheng together with PhD student Wang Xiaomeng at work at the AI chip design center.

A major goal of the center is to produce customized chips with a small design team to accelerate time to market.

by up to 1,000 times. At the same time, software-hardware co-designed solutions will enable companies of all sizes, including start-ups and smaller firms, to rapidly deploy their own customized AI-driven applications.

The pioneering center is being supported under the Hong Kong government's collaborative InnoHK Clusters initiative, receiving HK$443.9 million in initial funding. Participating universities comprise HKUST, Stanford University, the University of Hong Kong, and Chinese University of Hong Kong.

"Just think of all the sectors wanting AI acceleration, from transportation to fintech, medicine to education. It represents a massive opportunity for research, business, and social impact"

In recent years, advances in AI and machine learning accuracy have given rise to a greater number of AI-driven applications in areas such as face and object recognition, natural language processing, and autonomous vehicles. However, such developments have come at a price, with increased accuracy involving large computing and memory resources, long training periods for AI models, and major expense, limiting widespread use of such applications. ACCESS, established in 2020, is setting out to change this.

Customized computing chips for AI applications, also known as AI accelerators, are processors designed to speed up artificial intelligence and machine learning applications, including internet of things, computer vision, and other data-intensive or sensor-driven tasks. "Companies want to cram more and more intelligence into today's sensors and devices to enhance their functions," said Prof. Cheng, an internationally recognized leader in
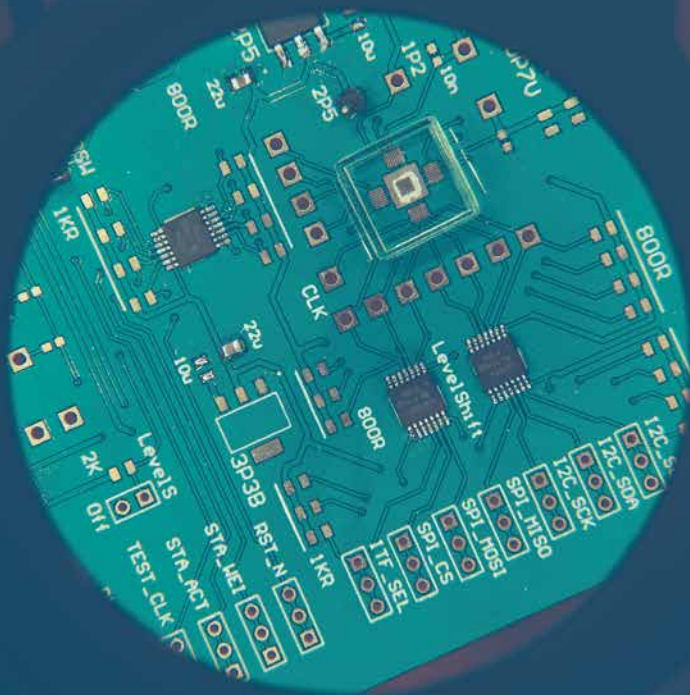
electronic design automation, integrated circuit design, and computer vision. "They need powerful but small, energy-efficient AI chips to carry out specific and ubiquitous tasks. But such embedded intelligence is not yet widely available."

The center's research areas address four key technical areas: enabling technology for emerging computer systems, architecture and heterogeneous system integration, AI-assisted electronic design automation for AI hardware, and hardware-accelerated AI applications. Among its 14 projects to date, teams are developing a new generation of computing in memory (CIM) chips that serve as independent data processors, eliminating the need for the chip to send data to the cloud or a central server for analysis and processing and then return the data. Getting rid of these steps can make the CIM chips hundreds of times faster, with current literature and results indicating that ACCESS chips are three times more efficient than the best-performing CIM chips currently available.

The center has also successfully designed a new generation of optimized neural network prototypes on computer architecture and hardware models and completed verification on a Field Programmable Gate Array (FPGA) platform. It is expected that final design and manufacturing of ultra-low-power chips will be completed in the second half of 2022.

"Just think of all the sectors wanting such AI acceleration, from transportation to fintech, medicine to education," Prof. Cheng said. "It represents a massive opportunity for research, business, and social impact, penetrating different market segments and product applications, and involving hundreds of millions of units." The global market for AI was estimated at US$47.1 billion in 2020 and forecast to increase to over US$290 billion by 2026.[1]

Another of ACCESS's innovative aspects is its bid to offer an alternative to the current business model for AI chip design, enabling a greater number of companies to obtain chips tailored more precisely to their specific needs.

"I think the center will put Hong Kong on the global map in this area. You have great customers, great technology, and the next stage is to tie this together with the AI hardware"

While giants such as Apple, Tesla, and drone-maker DJI can afford to employ large teams to design customized chips for their own devices (and sole use), such resources are beyond most companies. Firms requiring chips for AI products instead pass their algorithms and specifications to chip-design companies. However, the functions provided by the latter are often designed for a wide range of applications rather than optimized for a certain AI application and algorithm. This means client companies may only use a part of the purchased chip's functionality

[1] https://www.researchandmarkets.com/reports/1056044/artificial_intelligence_ai_global_market

A media conference introducing ACCESS and its work in November 2021 attracted substantial interest.
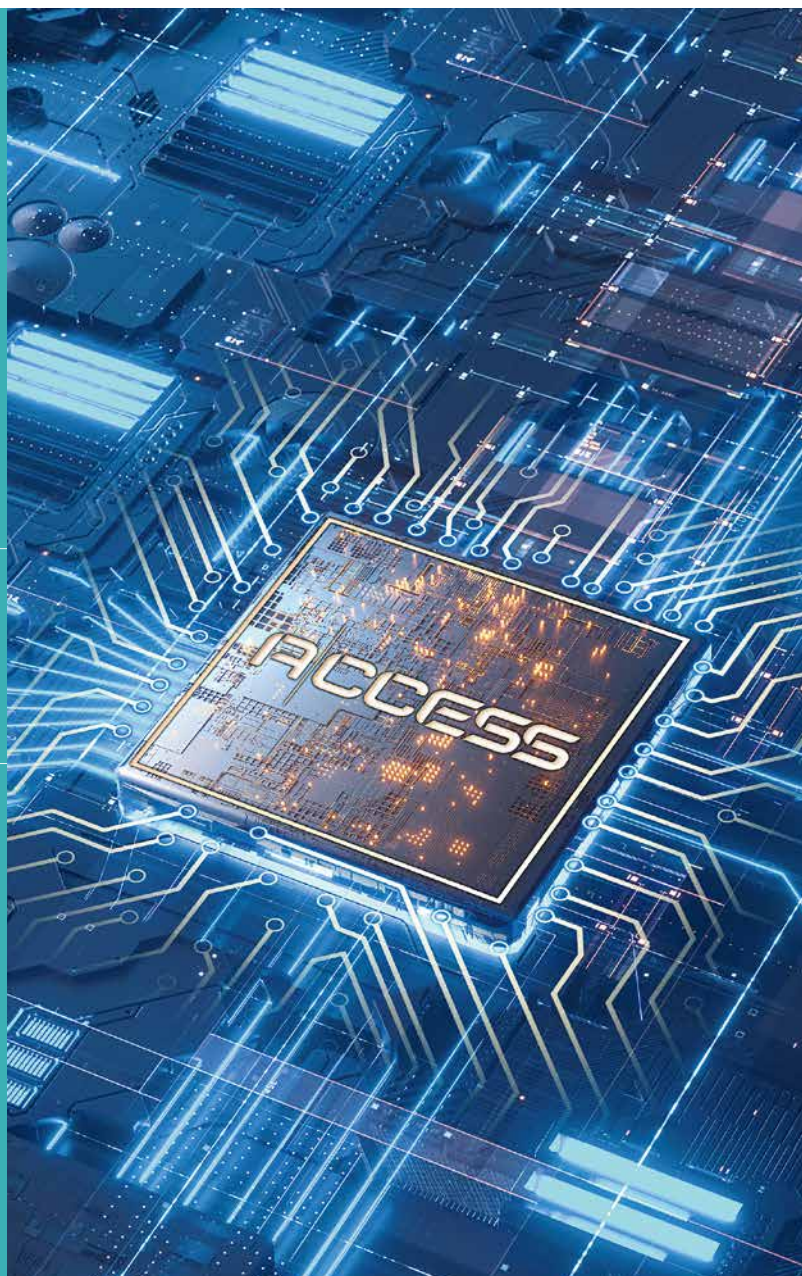
and potential performance, resulting in mismatch, wasted resources, and inefficiency. It also makes it harder for companies to differentiate themselves from their competitors' AI products.

ACCESS, on the other hand, has set out to devise open-source methodologies and tools for design automation, which enables AI customization to be rapidly carried out by relatively few designers, speeding up design productivity and time to market. "Our goal is to produce customized chips with a small team within a short period of time. Instead of years, it can be done in one to two quarters. Instead of hundreds of people being required to design these chips, it will involve a team of tens of people," Prof. Cheng said.

To deliver both increased AI chip performance and greater automation of design, the center's integrated R&D platform comprises an unusually broad array of research expertise spanning software, hardware, chip structure and design, and AI algorithms and applications, linking upstream to downstream. The center has taken on around 20+ researchers and engineers and is aiming to recruit a total of 80 full-time staff with extensive industrial experience. In addition, 36 top faculty members and over 100 doctoral researchers from the four universities are on board.

Its cooperative relationship with industry is another important factor, according to Prof. Cheng. Companies can gain advice from ACCESS researchers on AI algorithms and AI chip architecture offering the most efficient solutions for their businesses while ACCESS teams can learn more about the latest developments and requirements of the AI application market. Incubation of new start-ups would also result. "The need is mutual. We need to reach out for new applications and impact, and companies seeking applications already have customers that will be the beneficiaries. The next step is how to build a customized chip so their product becomes more competitive and energy efficient," he said.

Furthermore, such cooperation should see more university integrated circuit research being commercialized. "We always say the 'valley of death' is the gap between university research and industrial deployment. Universities can turn their concepts into demos but face many problems before they can reach production. Industry finds

The consortium of leading universities behind ACCESS has created a novel integrated basic research and development pipeline, offering a distinctive opportunity for top researchers and PhD students globally.

interesting demos from universities but needs several years to work out how they can apply them. ACCESS has been conceived to integrate the R&D pipeline and remove the valley of death, which I think is a unique opportunity."

Despite the center's work in AI and chip design being at the intersection of two of the hottest areas of electronics research, Prof. Cheng is optimistic about ACCESS's ability to attract top talents to Hong Kong given its distinctive integrated R&D pipeline, significant investment in resources by government, and HKUST's commitment to drive the hub forward. "Other research centers are not connecting all the different dots together as a unified center and can only do part of what ACCESS can do," he pointed out. It can thus appeal to both experienced researchers seeking to grow their experience in a cutting-edge transnational research center and young talents keen to gain wider knowledge and skills through the comprehensive range of expertise that the platform brings together.

Meanwhile, the location of ACCESS in Hong Kong and the openings provided by the Greater Bay Area, which already possesses world-leading domains in AI applications and infrastructure such as machine learning and computer vision technology, among others, offer tremendous potential for research and business development. "I think the center will put Hong Kong on the global map in this area. You have great customers, great technology, and the next stage is to tie this together with the AI hardware," Prof. Cheng explained. "We are in the right place at the right time."

Ubiquitous AI that sticks to its task

As AI extends its reach into different areas of people's lives, concerns are frequently raised around areas such as privacy, responsibility, and ethics. In this regard, Prof. Cheng noted that ACCESS's work focuses only on core application-specific AI, not general purpose. "We want a device to be more intelligent but intelligent only for the particular task you want for that device. Thus, we contain intelligence to a very specific application, a very specific task. Nothing more, nothing less."

An electrifying career in wireless communications

Leading-edge exploration at HKUST has brought Prof. Khaled B. Letaief a lifetime of rewarding achievement as a researcher and educator, along with the exhilarating prospect of a global 6G future

"It was like a dream coming true… one of the greatest honors of my life." So Prof. Khaled B. LETAIEF, former Dean of Engineering, recalled his reaction to the unexpected 3am email in 2021 announcing he had been elected to the US National Academy of Engineering (NAE).

The New Bright Professor of Engineering and Chair Professor in the Department of Electronic and Computer Engineering (ECE) was especially pleased for HKUST, given the majority of his career has been spent at the University, and as NAE membership is regarded globally as one of the highest accolades accorded to an engineer in academia or industry. The Tunisian-born academic joined the School of Engineering (SENG) in 1993 as an assistant professor, moving from the University of Melbourne in Australia to HKUST just two years after its establishment. Today he is the world's sixth most cited scholar in wireless publications with over 40,000 citations and an h-index of 90, as in February 2022, as well as 15 granted patents.

"As a 'home-grown' faculty member at HKUST, I was deeply honored and humbled to receive this NAE distinction," he said. He was equally delighted for his home country, which supported his education through scholarships and has recognized his subsequent achievements with the top honor of Best Tunisian Researcher or Inventor Abroad in 2020, an award presented by the President of Tunisia to a single recipient annually.

Prof. Letaief's leadership in wireless communications and networks extends over 30 years, from the field's emergent days – "wireless communications did not exist when I went to university" – to current research interests ranging from machine learning to tactile internet and 5G/6G systems. Among his many outstanding research achievements at SENG are contributions to advance the analysis, design, and performance evaluation of orthogonal frequency division multiplexing (OFDM). Specifically, he has studied the use of OFDM for high-speed wireless data access and developed enabling techniques for OFDM that include robust channel estimation, synchronization, and space-time processing.

In addition, he has created groundbreaking adaptive and resource allocation schemes, as cited by the NAE, which became a key technology in many wireless systems and has been vital in accelerating the explosive growth of broadband wireless communications, with impact on sustainable smart cities, internet of things (IoT), and many other areas.

Prof. Letaief accounts for this success in typically modest fashion. "I am lucky to work in a field that makes impact and that is appreciated… We chose to solve difficult problems that were considered impossible by some. When you find the solution, it becomes impactful, it opens a new field, and people start citing your papers."

Brought up in Tunisia's French-inspired education system in the 1970s and early 1980s, the young Letaief was among the top 200 high school graduates given full scholarships by the Tunisian government for undergraduate studies in the US in 1981. These elite teenagers only started to learn English the summer before flying over to North America in the fall for one semester of English studies ahead of their undergraduate programs.

In spring 1982, he started the prestigious bachelor's degree in electrical engineering at Purdue University in Indiana, completing the four-year program within three years and gaining distinction. He continued on to a master's and PhD in electrical engineering at the same university, with full scholarships from his home country. "I was inspired by Purdue's professors to become a scholar doing impactful research for humanity and providing solutions to the world," he said.

The highly positive experience with the Purdue faculty also made Prof. Letaief a firm believer that excellence as an educator had just as important a role to play in an academic career as research. In 1998, just five years after joining HKUST, he received the Michael G. Gale Medal for Distinguished Teaching, HKUST's highest University-wide teaching award. As Dean of the School of Engineering from 2009 to 2015, he further advocated this teacher-scholar philosophy and launched the School's Center for Engineering Education Innovation.

He finds teaching and interacting with his postgraduate students a special joy, fully acknowledging that conducting research, and writing papers and books are carried out as a team and not by him alone. "I love training the next generation and helping them to excel. When publishing papers, I put students' names first and give them credit. I hope they will become more famous than myself. I treat them like colleagues – they work *with* me, not *for* me," he said.

An optimist in outlook, Prof. Letaief's motivation in all his endeavors is powered by the view that "where there's a will, there's a way". "You need to have a vision, but the most important thing is the execution," he said. "A vision without execution is only a dream. I love challenges and try to set ambitious goals."

Thus, along with research and teaching, Prof. Letaief has taken up management roles including Head of the ECE Department, Director of the Wireless IC System Design Center, Founding Director of Huawei Innovation Laboratory, and Director of the Hong Kong Telecom Institute of Information Technology as well as the deanship. He has also embraced professional activities, which he sees as an essential part of a scholar's career, helping an academic to excel through interaction with diverse leading minds.

A member of the eminent Institute of Electrical and Electronics Engineers (IEEE), the main professional organization in his field, for over 30 years and an IEEE Fellow since 2003, he was elected founding editor-in-chief of *IEEE Transactions on Wireless Communications* in 2002

Prof. Letaief sees 6G will bring a paradigm shift, centered on the integration of communications, computing, control, and sensing plus AI.

and tasked with creating the journal from scratch with a team of 100 editors. The journal is now regarded as one of the most prestigious, with an impact factor of 7.016 in 2022. In addition, he served as President of the IEEE Communications Society from 2018 to 2019, nurturing the younger generation, extending ethnic and gender diversity, global reach, and promoting technological innovation.

Now, despite achieving top global standing in his field, he is determined to keep advancing our wireless future. Indeed, he and his co-authors have already looked ahead to envisage that future in "The Roadmap to 6G: AI Empowered Wireless Networks", published by *IEEE Communications Magazine* in 2019 and one of the world's first papers on the vision for 6G, including potential technologies and key trends.

"You need to have a vision, but the most important thing is the execution. A vision without execution is only a dream"

He sees that 6G will represent a revolutionary paradigm shift as it will not only center on increasing transmission speed but also be AI empowered. This will result in a wireless evolution from "connected things" to "connected intelligence" to enable interconnectivity among humans, things, and intelligence within a deeply intertwined cyber-physical world, he explained. For example, 6G's increased scalability, higher bandwidth and frequencies will enable practices such as remote surgery whereby a doctor cuts a vein on a computer in Hong Kong and a robot in New York will do the same to an actual patient.

Such a future will also support ubiquitous AI services and internet of everything (IoE) applications, including those for sustainable cities, augmented, mixed and virtual reality, brain-computer interfaces, autonomous transportation, e-health, and more. The 6G standard is expected to be completed as early as 2028, while mass commercialization could occur around 2030.

For young people starting to think about careers and how to contribute to this transformational world to come, it may seem that little from the past is likely to apply. Yet for Prof. Letaief, the pathway to such a contribution is as clear as when he himself was making this decision as a teenager – one that he is always thankful he made.

"If you wish to help solve grand challenges such as sustainability, health, security, and energy, you should pursue science and research," he said. "It will not only bring you lots of fun and personal satisfaction, but also allow you to make a difference by advancing technology for humanity."

Aerospace engineering educator flying high

$$\circ \underline{\text{Breguet Range Equation}} \circ$$

$$\frac{dW}{dt} = -c_T T$$

$$R = \int V dt$$

Level Flight
$$L = W$$
$$T = D$$

$$R = \frac{V}{c_T} \cdot \frac{1}{D} \cdot \left(\frac{W_0}{W_1}\right)$$
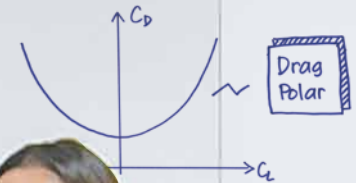
aircraft performance & propulsion

aerodynamics

structures

$$C_D = C_{D,0} + \frac{C_L^2}{\pi e AR}$$

Total Drag   Profile Drag   Induced Drag

Drag Polar

Making a complex subject fun to learn is part of Prof. Rhea Liem's approach to teaching.

Prof. Rhea Liem knows from challenging events as a teenager what a life-changing experience a top-flight education can be. Now she is seeking to inspire both learners and lecturers to head for the heights through her award-winning teaching

While 2021 may not have been the best of years for many people connected with aviation, last Fall there was a silver lining for Prof. Rhea LIEM, Mechanical and Aerospace Engineering, when she was named the recipient of Hong Kong's prestigious University Grants Committee (UGC) Teaching Award for early career faculty members.

The honor recognizes academics from the city's UGC-funded institutions for their outstanding teaching performance and achievements, as well as leadership and scholarly contributions on and off the campus. Prof. Liem said the award was not just for her. "I'm happier for the attention that goes to the aerospace program at HKUST, which is relatively new."

Prof. Liem was one of the first hires in the University's aerospace engineering program, joining the University in 2015, and still teaches two courses that she created: Introduction to Aerospace Engineering and Aircraft Design.

While the aviation industry is facing its biggest challenge in decades due to the COVID-19 pandemic, Prof. Liem remains a firm advocate of careers in the sector with many options beyond the traditional jobs of pilots, maintenance and aircraft engineers, including artificial intelligence and internet of things for aviation applications, financing, and aviation law. "I myself am working with industry and government to develop new methods and algorithms to improve overall air traffic efficiency by optimizing route coordination of arriving aircraft, so the prospects are not that gloomy," she said.

"My personal experience has taught me that education means hope and a better future, and it can truly change one's life"

Noting in her acceptance speech at the UGC award ceremony that learning about aerospace engineering can never be easy, she stressed that it can be made enjoyable, even when difficult, through lively discussion related to real-world examples, such as air crash investigations, and case studies on amazing aircraft designs.

Another key element in the learning process, according to Prof. Liem, is the involvement of the students. One significant way she encourages this is to allow members of her courses to choose their own topics for term papers as part of the self-learning experience and to take ownership

Receiving the UGC Teaching Award for early career faculty.

Prof. Liem on the flight simulator at Cathay City.

of their own learning journey, which she regards as "the best motivation a student can have".

"I have treated my students as partners since the very beginning," she said. "It's important that students feel they are acknowledged."

She also believes it is important to be a role model to girls interested in engineering. This was brought home to her following a talk she gave at the University of Indonesia in 2016. After the session, many students approached her saying they were hesitant about pursuing engineering because they kept being told it was not for women.

"To them, seeing a female engineer talking about aircraft design was an eye-opener. Well, their candid sharing was an eye-opener for me too," she said. "I hope that other fellow female engineering faculty members and I can continue reaching out to girls whenever such opportunities arise."

Prof. Liem considers herself fortunate that neither her family nor her all-girls high school in her home country of Indonesia questioned her choice to study mechanical engineering, noting her father taught science to his daughters as well as his son when they were growing up. However, in her first job as an R&D engineer, she was the only female engineer working on a project in a team of more than 20.

She recalled that one day, the manager had pulled her aside to ask: " 'Are you sure you can cope with this engineering work since you are a female? We've never had any female engineers before.' My response was: 'I have a mechanical engineering degree too, so how does being a

female have anything to do with it?' He could not answer that, and I survived in that job."

For Prof. Liem, the biggest reward of being an educator is seeing the transformation of those she teaches. One example she cites is a student who initially struggled academically but persisted in his research and self-study to eventually achieve success, receiving an internship and even going on to consider a career in research. "I have witnessed his change from questioning himself to finding his own identity," she said. "I always say to students: 'Focus on what's important, not what's urgent.' "

This desire to transform lives through education is based on her own experience when growing up. When she was 16, her father suddenly became seriously ill, with her family losing its business and income in Jakarta. Reminded in those bleak and uncertain times by her mother that "education is the best investment you could make to yourself", she studied hard at school, earning a scholarship to Nanyang Technological University in Singapore to study mechanical and production engineering.

"My students should be able to see the purpose of their learning beyond academic excellence"

After working as an engineer in Singapore for three years, she went to the United States to do a master's degree at the Massachusetts Institute of Technology and discovered her passion for aerospace engineering. She left with two master's degrees, in computation for design and optimization, and aeronautics/astronautics, heading on to the University of Toronto to earn a PhD in aerospace engineering. Her next move was to HKUST, which was just establishing the aerospace program and looking for new faculty members.

She found the move from doctoral researcher into the world of teaching "a baptism of fire". "I was really nervous at the beginning as I never thought teaching could be my career. I still remember I felt jetlagged and sick for the first few days of teaching.

But as soon as I started talking in class, I was instantly energized," she said, adding it was at that moment that she realized that being an educator was her vocation.

To increase her educator skills, she spent months taking additional workshops at HKUST's Center for Education Innovation and took great care preparing her teaching notes. Such efforts did not go unnoticed. Her teaching philosophy and care for students brought her the School of Engineering's Teaching Excellence Appreciation Award in 2017-18 and 2020-21, in addition to the UGC award.

The UGC honor will enable Prof. Liem to extend her educational sights by developing a new experiential learning course called Student Innovations for Engineering and Science Teaching Aids (SIESTA). Through SIESTA, students will be able to design and develop science demonstration kits or hands-on science, technology, engineering, and mathematics (STEM) learning toys for primary and secondary school students, including underprivileged children in Hong Kong and developing countries.

This will also see her furthering her goal to help students gain a positive and wider view of education and the key role it can play in a person's life. "My personal experience has taught me that education means hope and a better future, and it can truly change one's life. Furthermore, education is also about paying it forward," she said on receiving the UGC award. "My deep appreciation toward learning and education motivates me to instill a positive and purpose-driven attitude toward learning into my students. My students should be able to see the purpose of their learning beyond academic excellence."

Prof. Liem in action in the classroom. "I have treated my students as partners since the very beginning."

Doctoral dynamos

Two Chemical and Biological Engineering PhD students describe the diverse opportunities beyond their studies in the School of Engineering's energizing research environment

Ivy WONG Hei-Man
Year 3, PhD in Bioengineering
Lead Engineer, PhoMedics

Some might hesitate to pursue a doctoral degree since it seems the only career destination is academia and the life of a PhD student is nothing but "permanent head damage" and 24 hours in the lab. While it might be true that I spend long hours in my lab, a PhD is certainly a lot more than a degree – it is a part of my career-building, from academia to application. What I wish to achieve is not only good research but to translate this work into practical use.

In my postgraduate life, I have been primarily working on CHAMP (computational high-throughput autofluorescence microscopy by pattern illumination), a thick tissue imaging technology that provides cellular images to assist surgeons in determining if cancer cells have been completely removed. Current procedures can take days before results are generated. For patients, this means living in fear for a lengthy period, anxiously waiting to hear whether they will need a second operation. With CHAMP, analysis and results can be returned in three minutes during surgery, eliminating the need for second operations, which I see as a really meaningful development.

Hi-tech CHAMPions: Ivy Wong (front row, center), with her PhoMedics teammates and start-up founder Prof. Terence Wong (second row, right).

I have also gained the opportunity to form a start-up, PhoMedics, with fellow researchers and supervisor Prof. Terence WONG to translate CHAMP technology to a marketable product. There are many new areas to tackle when setting up a company, ranging from product design to regulatory concerns and business strategy. It is certainly challenging but together with a good team from diverse backgrounds, and the support and funding provided by HKUST for its spin-offs, we are growing collectively.

It is never wrong to become a PhD student if you are looking for a challenge in realizing your idea. A PhD in engineering does not mark the end in the field. On the contrary, it provides good training to equip yourself with a problem-solving mindset to accept new challenges. It could even be the first step to building your own career in technology innovation.

It is especially true for women who want to take a shot at joining the pack! Undoubtedly, we work in a vigorous field, but engineering is one that treasures innovation, logic, and cautious validation, qualities that both men and women possess. In fact, many of my female friends in Hong Kong and abroad are doing very well in their respective areas.

Science and engineering never discriminate, and I do look forward to seeing more women in these spheres!

Pathways to a HKUST PhD

Born
Cheung Chau, Hong Kong

Inspiration
Hong Kong Chemistry Olympiad at high school and opportunity to participate in the iGEM international research project competition in Boston as a HKUST undergraduate

Education
BEng in Chemical and Biomolecular Engineering (First Class), HKUST (2019)

Awards
Butterfield Croucher Studentship 2021 (Best Candidate of Medical and Biological Sciences)

Croucher Research Studentship 2021

Gold Award, PhoMedics, HKUST-Sino One Million Dollar Entrepreneurship Competition 2020

Dean's List (5 times)

Usman Bin SHAHID

Year 4, PhD in Chemical and Biomolecular Engineering
People's Choice Award, Asia-Pacific Three Minute
Thesis (3MT®) Competition 2021

My doctoral journey at HKUST has been a fascinating one. I have had the opportunity to interact with some great minds while, as one of the best institutions globally, HKUST combines the perfect tools and environment to extend your skills and achieve your goals.

In addition to research, for example, PhD students at HKUST must take a professional development course, with content ranging from presentation and writing skills to research ethics. In one of these sessions, I met Mr. Graham YOUNG, then a presentation skills training instructor, who really encouraged me to try out for the Three Minute Thesis (3MT®) Competition.

This contest challenges PhD students to explain their research to a non-specialist audience in 180 seconds. My thesis relates to electrochemical ammonia synthesis, and I had not attempted anything like this before, so I was a bit daunted at first. But a few sessions with Graham gave me the necessary confidence to enter. And would you believe it! I was named first runner-up in my first year in 2019 in the internal HKUST 3MT® Competition and again in my third year in 2021.

Even more exciting, the second time I was able to represent HKUST at the Asia-Pacific 3MT® 2021,

Talking point: the single slide allowed in Usman's three-minute thesis presentation for the 3MT® contest.

where I eventually made it to the final round and won the People's Choice Award. Reaching the top eight among 54 participants from around the globe was itself an honor for me. But being the first student from a Hong Kong university to win an award is an experience that words cannot do justice to – and will be the highlight of my tenure at HKUST.

I am grateful that I could participate in such a competition because it helped me develop essential skills for a successful academic career. I learned how to condense the why, what, and how of my thesis and its goal to achieve a brighter and cleaner future by sustainably producing ammonia – the second most-produced inorganic chemical in the world and a key ingredient for 90% of all fertilizers. This puts in perspective the wider purpose of your work and also enables you to share your work with literally everyone, from an eight-year-old to someone at 80! Such an achievement would not have been possible without the support of the School's instructors, faculty members, and staff.

Indeed, the entire PhD experience at HKUST has been enlightening. As a researcher, the quality of work carried out for your PhD plays a critical role in defining your long-term career. An intellectual group of peers and a competitive environment push you to explore boundaries that may feel intimidating at times. However, through collaborative effort, you can overcome all challenges and make breakthroughs that genuinely revolutionize the field. This is something I truly cherish at HKUST.

View Usman's award-winning 3MT® presentation

Pathways to a HKUST PhD

Born
Lahore, Pakistan

Dream
A lab of his own to make "cool things" that impact the wider community after being inspired as a child by the TV cartoon series *Dexter's Laboratory*
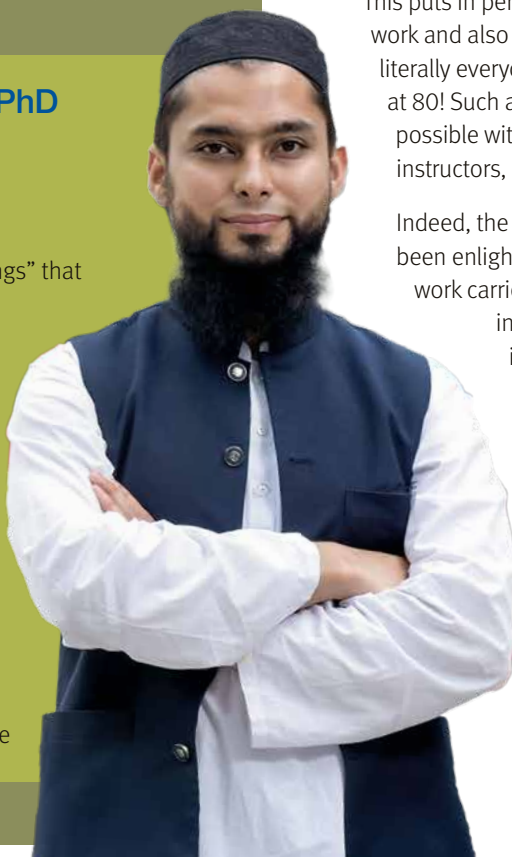
Education
MS in Sustainable Environment, Hamad Bin Khalifa University, Qatar (2018)

BEng in Chemical Engineering (Distinction), McGill University, Canada (2013)

Scholarship
Hong Kong PhD Fellowship Scheme

The alchemy of care

By Prof. Raymond Wong

To me, teaching is all about being an "alchemist". Historically, an alchemist is a person with the magical power of transmuting a common substance into one of great value. In the context of my educational philosophy, an alchemist is a teacher who has the ability to transform a student into an excellent learner.

I see the pathway to becoming an "alchemist" as centering around nine principles:

- **A**ctive interaction
- **L**istening
- **C**are
- **H**igh-quality teaching
- **E**agerness to take challenges
- **M**otivate students to work harder and develop their skills
- **I**nspire students
- **S**haring
- **T**echnology

As these principles show, to achieve excellence as an educator and serve as a catalyst for unlocking the potential for achievement and excellence in students, I regard it as pivotal not only to help students develop intellectually, but also as people capable of managing diverse situations and challenges in their lives. That is why my focus for this column is "Care", a core element of building a relationship and mutual trust between an instructor and students, yet an aspect too often overlooked as an ingredient for accomplishment.

"When students drop by my office, I always try to stop what I am currently engaged with to listen and help solve issues"

What does "care" entail? For each student I meet, I try my best to understand their needs – academic or non-academic – to see whether I could help. This often involves listening wholeheartedly, also one of my "alchemist" principles, to whatever they wish to share. Despite an extremely busy schedule, when students drop by my office, I always try to stop what I am currently engaged with to listen and help solve issues that are troubling them. I also regularly arrange meetings to find out any difficulties that students may be encountering with courses and workload.

Feedback I have received during my 14 years at HKUST shows that students really appreciate and benefit from such empathy and attention. One wrote: "In many ways, I regard Prof. Raymond as not just an advisor but also a mentor and a good friend." Another stated: "Prof. Raymond is a friend, a role model, and most importantly a father figure who motivates me to work harder." As such, I see that along with well-designed assignments, creativity, and academic exploration to stretch students' minds and generate top results, educators must also pay much more attention to students' feelings, stresses, and the hurdles they face.

With care from professors integrated into the drive for outstanding research outputs and well-developed programs that often appears to dominate many universities, especially in Asia, we could shape our higher education to transform students more successfully into excellent learners, both academically and in their subsequent lives.

21st century engineers
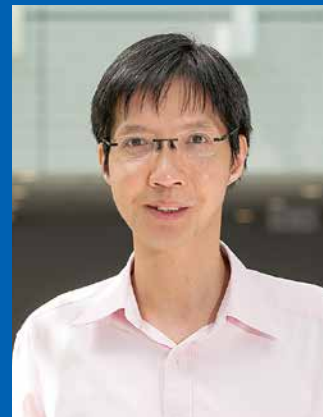
Prof. Raymond WONG is Associate Head (Education) in the Department of Computer Science and Engineering. He received the University-wide HKUST Michael G. Gale Medal for Distinguished Teaching 2020, Common Core Teaching Excellence Award (Honorary Mention) 2016 and 2019, and School of Engineering Teaching Excellence Appreciation Award 2015-16 and 2019-20.

Breathing easier

Spurred by her School of Engineering student days to become an atmospheric scientist, alumna Prof. Sally Ng Nga-Lee is advancing sustainability through her leading air quality research, as well as fostering the next generation of aerosol explorers

Clearing the air has had a special meaning for alumna Prof. Sally NG Nga-Lee ever since her days as a Chemical and Environmental Engineering undergraduate at the School of Engineering (SENG) 20 years ago. Indeed, she has gone on to make it her life's work to contribute to improving global knowledge of air quality and its impact on human health and climate change.

Now a tenured Professor in the School of Chemical and Biomolecular Engineering at Georgia Institute of Technology in the US, with a joint appointment in the university's School of Earth and Atmospheric Sciences and a courtesy appointment in the School of Civil and Environmental Engineering, the atmospheric scientist is opening up fresh horizons in her field by extending knowledge of fundamental chemical mechanisms related to the formation and composition of aerosols (fine particles suspended in air) through her research and teaching.

"The opportunity to participate in undergraduate research and the exchange program truly shaped my career path"

Most recently, in October 2021, she and her inter-university team received US$12 million in grant money from the National Science Foundation in the US to generate high time-resolution (every 1 to 15 minutes), long-term measurements of aerosol properties. The work will be carried out via a network of 12 sites nationwide in a project officially known as the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). The resulting data will assist understanding of how sustainability-based changes

Prof. Sally Ng Nga-Lee inside the Environmental Chamber Facility in her lab at Georgia Institute of Technology, where she is delivering greater understanding of aerosols and air pollution.

to electricity production and transportation are affecting air pollution and climate change variables.

In March 2021, she was among the scientists featured by the US' National Oceanic and Atmospheric Administration (NOAA) for Women's History Month, an annual international celebration of women's contributions in history and contemporary society.

As Sally noted in the NOAA article: "I like that my work allows me to explore the unknown, discover, and learn something new and exciting all the time. I have the flexibility to pursue any research topics that I deeply care about."

In an email conversation with SENG, she also explained that she chose academia rather than a career as a researcher in industry or government as she really enjoys the enthusiasm and curiosity of students. "During my graduate studies and postdoctoral research, I had many opportunities to work with junior students. I found it very rewarding to be able to pass on my knowledge, learn new things, and grow with them. I enjoy learning and would

Sally graduated from HKUST with a BEng in Chemical and Environmental Engineering (First Class) in 2002, moving on to a MS and PhD in Chemical Engineering at the California Institute of Technology (Caltech), and joining Georgia Institute of Technology in 2011 after three and a half years at an R&D company.

As an academic, she finds her life continually interesting and satisfying. "It is quite a lot of work to build a research program from scratch. But it is also very fulfilling and rewarding when things come together and to see the scientific, professional, and personal development of students over the years."

"I think being a professor is the closest I can get to be a student forever"

She also recalled how on deciding that career path, she let passion for her subject guide her decision-making. "Back in those days, my decision to choose to major in chemical engineering in Hong Kong was perceived as an unconventional choice by many. But I think it's important to choose what one loves to do. Then things will work out, one way or another."

On her latest ASCENT project, she sees an advanced, long-term atmospheric aerosol network as critical in providing the measurements needed for informing science-based decisions on climate and environmental change. "We are very excited about this opportunity to establish ASCENT and we hope to strengthen collaborations with international atmospheric observation networks, including those in Asia," she said.

have loved to be a student forever, and I think being a professor is the closest I can get to be a student forever."

Interested in chemistry and mathematics in secondary school, Sally's search for a university program combining these two subjects led her to SENG, which provides the only chemical engineering department at a Hong Kong university. When she received a positive response to her enquiries from then Department Head (now Professor Emeritus) YUE Po-Lock – "to my delight and surprise, Prof. Yue took the time to respond to my email and explain what chemical engineering was about" – and learned of the Chemical and Environmental Engineering bachelor's degree, she decided to make it her major.

At SENG, Sally had the opportunity to participate in undergraduate research under the supervision of Prof. CHAN Chak-Keung, learning about aerosols and air quality. She also went on a one-year exchange to the University of Minnesota in the US, where she realized the air quality in Minnesota was much better than in Hong Kong. She then decided, with the encouragement and guidance of Prof. Chan, to apply for graduate programs in the US to learn more. "The opportunity to participate in undergraduate research and the exchange program truly shaped my career path," she said.

Sally first learned about aerosols during an undergraduate research project at the School of Engineering, an experience that helped shape her career choice to study air quality.

Students & Alumni

Computer Science and Engineering PhD student **WU Aoyu** was awarded a 2021 Microsoft Research Asia Fellowship. Aoyu was one of 11 PhD students selected from over 150 candidates from 50 leading research academic institutions in Greater China and the Asian region. His research interests include data visualization and human-computer interaction. He also leads Pulse of HKUST, a data-driven platform that supports smart campus development.

Year 4 Electronic and Computer Engineering undergraduate **Anushka PUROHIT** was named "Young Achiever of the Year" at the 18th Annual Women of Influence (WOI) Conference & Awards, organized by the American Chamber of Commerce in Hong Kong and the WOI committee. She was cited for her sustainability achievements and for co-founding food upcycling start-up Breer (see item below), which collects surplus bread and uses it to create craft beer.

HKUST start-up teams Breer and PanopticAI were named Champions of Environment Sustainability and Social Connectivity respectively in the university/tertiary institute category of Hong Kong's first City I&T Grand Challenge. Breer, a food upcycler, also gained the Most Favored Award after receiving the largest number of votes from the public. Breer comprises **Anushka PUROHIT**, Electronic and Computer Engineering (see above item), and her teammates from the School of Business and Management. PanopticAI focuses on innovative camera-based remote health monitoring technology. It was co-founded by Bioengineering PhD candidate **Kyle WONG Kwan-Long** (left, below), Industrial Engineering and Decision Analytics (IEDA) Class of 2021 graduates **Dr. CHIN Jing-Wei** (PhD) and **CHAN Tsz-Tai** (MPhil), and **Prof. Richard SO**, IEDA and Associate Dean of Engineering (Research & Graduate Studies). In addition to the City I&T Grand Challenge awards, Breer won the 2021 HKUST-Sino One Million Dollar Entrepreneurship Competition while PanopticAI received the Grand Prize for the entrepreneurship track and First Prize in the start-up category at the 7th Hong Kong University Student Innovation and Entrepreneurship Competition.

Dr. CAO Zhixing (2016 PhD in Chemical and Biomolecular Engineering) has been named one of the 35 Innovators Under 35 Asia Pacific 2021 by *MIT Technology Review*. He received the accolade for his work on cell biological mechanism discoveries using mathematical modeling, which is helping scientists gain new insights into cancer therapeutics, vaccine development, drug discovery, and other cytological issues. He is now a full professor at East China University of Science and Technology in Shanghai.

Faculty

External honors

Prof. Ricky LEE Shi-Wei, Chair Professor of Mechanical and Aerospace Engineering and Acting Dean of the Systems Hub at HKUST(GZ), has received the 2021 Avram Bar-Cohen Memorial Award (previously the InterPACK Achievement Award) from the American Society of Mechanical Engineers, becoming the first Chinese scientist to win the accolade. Prof. Lee's research focuses on the development of packaging and assembly technologies for electronics and optoelectronics.

CLP Holdings Professor of Sustainability **Prof. Charles NG Wang-Wai**, Chair Professor of Civil and Environmental Engineering, Dean of HKUST Fok Ying Tung Graduate School, and Vice-President of HKUST(GZ), has received a 2020 Natural Science Award (Second Class) from the State Council for research contributions to mitigation of construction accidents and natural disasters caused by unsaturated soils.

Prof. Andrew POON Wing-On, Head of Electronic and Computer Engineering (ECE), has been elected a 2022 Fellow of Optica (formerly known as The Optical Society [OSA]) in recognition of outstanding contributions to microcavity optics and photonics and their applications in silicon photonics. This brings the total number of Optica Fellows in ECE to five.

Prof. Ying CHAU, Chemical and Biological Engineering, was named "Leading Woman in STEM" at the 18th Annual Women of Influence (WOI) Conference & Awards, organized by the American Chamber of Commerce in Hong Kong and the WOI committee. Prof. Chau was lauded for her education and research capabilities, strong entrepreneurial skills, and social impact. She is the Founding Director of the Student Innovation for Global Health Technology (SIGHT) initiative at HKUST, an undergraduate education platform that enables students to work on innovative solutions for healthcare problems around the world.

Prof. Guillermo GALLEGO, Crown Worldwide Professor of Engineering and Chair Professor of Industrial Engineering and Decision Analytics, was awarded the INFORMS Revenue Management and Pricing Section Prize for the second time. He received the 2021 honor for his co-authored paper, "A Markov Chain Approximation to Choice Modeling", published in *Operations Research* (Vol 64) in 2016. The award is presented to the best contribution to the science of pricing and revenue management published in English over the past five years. Prof. Gallego first received the prize in 2005.

Prof. SUN Fei, Chemical and Biological Engineering, was named a 2021 Excellent Young Scientist by the National Natural Science Foundation of China. The award is one of the most prestigious honors for young academics in China. It supports promising scholars who have already achieved good results in basic research in pursuing further innovative studies. Prof. Sun's research interests range across synthetic biology, protein engineering, chemical biology, and biomaterials.

Prof. Pascale FUNG, Electronic and Computer Engineering, has been elected a 2022 Fellow of the Association for the Advancement of Artificial Intelligence "for significant contributions to the field of conversational AI and to the development of ethical AI principles and algorithms". She was one of only 10 Fellows elected.

Prof. YANG Qiang, Chair Professor of Computer Science and Engineering, was elected a 2021 Fellow of the Royal Society of Canada. He was also elected a 2021 Fellow of the Canadian Academy of Engineering. Prof. Yang is a world leader and pioneer in the artificial intelligence fields of transfer learning and federated learning, as well as automated planning and case-based reasoning.

Prof. Man WONG, Electronic and Computer Engineering, has been awarded the 2021 Slottow-Owaki Prize by the Society for Information Display. The award honors outstanding contributions to the education and training of students or professionals in the electronic display field. Prof. Wong is a leading figure in the display industry with prolific work in the area of thin-film transistors. He is HKUST's third recipient of the prize.

Prof. ZHANG Jun, Electronic and Computer Engineering, has been elected a 2022 Fellow of the Institute of Electrical and Electronics Engineers (IEEE), bringing the number of IEEE Fellows among School of Engineering faculty to 42. Prof. Zhang was recognized for his contributions to dense wireless networks.

New appointments

Administrative

Prof. Tim CHENG Kwang-Ting
Appointed Vice-President for Research and Development (effective April 1, 2022)
Chair Professor, joint position in Electronic & Computer Engineering and Computer Science & Engineering

Prof. Bert SHI
Appointed Acting Dean of Engineering (effective April 1, 2022)
Professor, Electronic and Computer Engineering

Prof. MOW Wai-Ho
Appointed Associate Dean of Engineering (Undergraduate Studies)
Professor, Electronic and Computer Engineering

Prof. WANG Yu-Hsing
Appointed Associate Dean of Engineering (Undergraduate Studies)
Professor, Civil and Environmental Engineering

Prof. ZHANG Jiheng
Appointed Head of Department of Industrial Engineering and Decision Analytics
Professor, joint position in Industrial Engineering & Decision Analytics and Mathematics

Prof. QU Huamin
Appointed Head of Division of Emerging Interdisciplinary Areas
Director of Interdisciplinary Programs Office
Chair Professor, joint position in Computer Science & Engineering and Electronic & Computer Engineering

Faculty

Prof. CAO Xuanyu
Assistant Professor, Electronic and Computer Engineering
PhD – University of Maryland

Prof. CHEN Yangyang
Assistant Professor, Mechanical and Aerospace Engineering
PhD – University of Missouri

HKUST

A 2021 HKUST Honorary Fellowship was conferred on **Prof. YU Tongxi**, Professor Emeritus of Mechanical and Aerospace Engineering. Prof. Yu, an expert on impact dynamics and plasticity, joined HKUST in 1995. He served as Chair Professor and Head of the Department of Mechanical Engineering, among other senior University roles. Such responsibilities encompassed establishing the HKUST Fok Ying Tung Graduate School in Nansha, Guangzhou, where he became Founding Dean. Since his retirement in 2010, Prof. Yu has continued to publish papers and to serve in different posts at the University, including Senior Advisor to the President.

Four faculty were honored at the School of Engineering Teaching Excellence Appreciation Awards 2020-21. The Distinguished Teaching Award was presented to **Prof. Terence WONG** (first left), Chemical and Biological Engineering. Teaching Awards went to **Prof. Andrew HORNER** (second left), Computer Science and Engineering, **Prof. Rhea LIEM** (second right), Mechanical and Aerospace Engineering, and **Prof. Ross MURCH** (first right), Electronic and Computer Engineering. The awards go to faculty members who have demonstrated exemplary insights and efforts in reinventing engineering education. **Prof. Horner** and **Prof. Wong** also received Honorary Mentions in the Common Core Teaching Excellence Award 2020 for their courses on Creative Sound Design and Introduction to Biomedical Engineering, respectively. These accolades recognize outstanding instructors who have made substantial contribution to the design and/or teaching of exemplary common core courses and promotion of these courses to the University's students.

Prof. CHEN Yi
Assistant Professor, Industrial Engineering and Decision Analytics
PhD – Northwestern University

Prof. CHENG Minhao
Assistant Professor, Computer Science and Engineering
PhD – University of California, Los Angeles

Prof. DUAN Molong
Assistant Professor, Mechanical and Aerospace Engineering
PhD – University of Michigan

Prof. HUANG Wei
Assistant Professor, Mechanical and Aerospace Engineering
PhD – University of California, San Diego

Mr. Brian LAU Hui-Wang
Lecturer, Integrative Systems and Design

Dr. Khawar SARFRAZ
Lecturer, Electronic and Computer Engineering
PhD – The Hong Kong University of Science and Technology

Prof. WANG Zhe
Assistant Professor, Civil and Environmental Engineering
PhD – Tsinghua University

Prof. YANG Yansong
Assistant Professor, Electronic and Computer Engineering
PhD – University of Illinois at Urbana-Champaign

Prof. YU Yantao
Assistant Professor, Civil and Environmental Engineering
PhD – The Hong Kong Polytechnic University

Prof. ZHANG Jize
Assistant Professor, Civil and Environmental Engineering
PhD – University of Notre Dame

Prof. ZHANG Shenghan
Assistant Professor, Civil and Environmental Engineering
PhD – Swiss Federal Institute of Technology, Lausanne (EPFL)

Setting the stage for artistic encounters

The main hall delivers a world-class acoustic experience.

Technology and the arts are set to be drawn closer together with the opening of HKUST's inspirational multi-purpose Shaw Auditorium in November 2021. The landmark addition will bring further campus diversity, nurturing creative talents and fostering whole-person development among the University's science, engineering, business, and humanities and social science students. It will also serve as a significant link between HKUST and the wider community.

The four-story elliptical auditorium, designed by Danish architect Mr. Claude Bøjer GODEFROY and completed in time to celebrate the University's 30th anniversary, was supported in part by a HK$150 million donation from the Shaw Foundation Hong Kong.

Mrs. Carrie LAM, Chief Executive of the HKSAR Government, gave the keynote speech at the opening ceremony, with eminent officials, community leaders, and senior University management among the 500 attendees.

The venue offers different operational modes, allowing flexible adaptation to events ranging from concerts to exhibitions to University-wide

occasions, such as the Congregation, among others. State-of-the-art technical features include a one-of-a-kind cyclorama and edge-blend projection display, and an immersive sound system. In addition, its energy-saving design and top indoor environment quality have brought a BEAM Plus Platinum provisional rating from the Hong Kong Green Building Council.

With the auditorium in place, HKUST will drive forward the interplay between the arts and technology, making arts-related courses compulsory for most programs.

The imaginative Shaw Auditorium will help the University integrate the arts into its programs.