

The Hong Kong Institution of Engineers
Control, Automation & Instrumentation Division Summit 2022
26 February 2022

It's Time to Change, NextGen. of Control, Automation and Instrumentation

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Ir LOCK (Chairman), Ir SIT (S for IT), Ir Dr. LO (Wai-kwok), distinguished guests, ladies and gentlemen,

Good morning. It gives me great pleasure to meet you all online today, and share my views regarding the next generation of Control, Automation and Instrumentation.

Exercising Control to Management Changes

When given today's theme of "It's time to change", the word "change" immediately took my attention. We all live in an ever changing world, and we are faced with challenges arising from various changes every day, especially under the new normal brought by the epidemic. In fact, an awesome lot of our lifestyle have changed – wearing of masks, sanitizing of hands, fever checking at virtually everywhere, to name but a few. But these measures in turn have not stopped evolving in the past two years as the epidemic goes along. Winston Churchill once said, "To improve is to change, to be perfect is to change often". I believe everyone would echo Churchill's view on the importance of change, which leads me to think of the question "what are the major changes ahead of us"? Let me start by sharing with you two major changes that I believe are of utmost importance to our future.

What are the Changes ahead of us?

Technological Change

The first change I would like to talk about is the rapid change in technology. In the past, control and automation of systems are performed by the proportional–integral–derivative controller, or PID controller in short. Subject to the measurable feedback, which is the difference between the intended outcome and the known actual result at the moment, we fine tune our system control with a view to getting the desired outcome. That is, we adjust the

control based on what is already known to us. Now, thanks to the nano-technology, low power sensors, edge computing and even quantum computing in the near future, more and more monitoring and processing capacity have been injected to our systems, enabling new features like big data, machine learning and AI technologies. Unlike the traditional PID control, these new features have the added prediction capability based on experience learned in the past to achieve the desired outcome in a faster and smarter way.

Apart from the smart control system, a high speed and low latency communication network is also vital to enhance the coverage and information transmission of our system. Traditionally, we are bound by wired communication networks in implementing control systems. Nowadays, with 5G technology providing high transmission rates and extremely low latency, we are now able to expand our control system with many more feedback inputs and without the limitation of cables. And it doesn't stop there, the network is getting faster and faster. The Purple Mountain Lab of our Country has just recently announced their successful trial of its photonic wireless communication system with a throughput of over 200 Giga-bits per second¹, some 20 times faster than 5G. Working at the tera-hertz frequency range, the system can avoid the potential interference issue, and has the great potential to be a candidate for future 6G technology.

I believe that technological change will enable a fully digitalised, automated and programmable world of connected humans, machines, things and places. This resembles Mike Zuckerberg's vision of the Metaverse, where we are no longer looking at the internet or the control panels, but actually participating in the system. While the boundaries of physical and virtual realities are diminishing, the challenge ahead, however, is how we are going to prepare ourselves for this paradigm shift from the traditional engineering sense.

Climate Change

While technological change are going to bring us more good than bad, the other change I am going to talk about is the one that we shall all be concerning and combating. Climate change has evolved into the single most crucial problem to tackle in this generation, and we are approaching the decisive moment for efforts to tackle the climate crisis, arguably the greatest

¹ <https://www.pmlabs.com.cn/plus/view.php?aid=1507>
(紫金山实验室发布面向 6G 的太赫兹 100/200Gbps 实时无线通信重大成果)

challenge of our times. Responding to that call of our times, our country is committed to achieving peak carbon dioxide emissions before 2030 and carbon neutrality before 2060. To signify Hong Kong's commitment, the Government announced last year our pledge to achieve carbon neutrality before 2050. In Oct 2021, the Government announced Hong Kong's Climate Action Plan 2050, setting out the vision of Zero-carbon Emissions and sustainable development in Hong Kong and outlining four major de-carbonization strategies, namely "Net-zero electricity generation", "Green transport", "Waste reduction" and "Energy saving as well as green buildings". In the coming decades, carbon is no doubt the most important element we need to "control", and our attitude towards carbon emission is again, our mindset towards "change".

Redefining C. A. I. to Embrace Change

Dealing with these changes would require the work of the whole society. But when talking about dealing with change to attain perfection, control engineers are probably the best trained professionals in our society to lead us in the task. The Oxford Learner's Dictionary defines "control" as the act of limiting or managing something or a method of doing so, citing examples as traffic control, arms control and damage control. In real life, control engineers deal with controlling processes and feedback loops so as to achieve desired outcomes, with respect to cost and quality, and the process is repeated all over again. Through finely exercising the profession, or I shall even say the art of control, control engineers have brought numerous achievements to the human race over the years, from boilers and turbines to signaling systems and building automation. And today, I would attempt to enrich the meaning of the C.A.I., the name of the CAI Division which is the home to Hong Kong's finest control engineers, so that we can better prepare to control these changes.

CONNECT

GWIN to Connect Sensors

I would first start by talking about the C, which stands for "Connect". As I have mentioned earlier, technological change has brought about much opportunities through enhanced connectivity, and engineers can now exploit these connections to expand their system from the component level to a city-wide level. Citing the opportunity, the EMSD has built a Government Wide Internet-of-Things Network, or GWIN in short, connecting sensors for remote monitoring of E&M equipment to support smart city management. GWIN, is based

on low power and private Long Range network, and the sensors to gateway distance supported is up to 10km. It is a more cost-effective means when compared to cellular network for implementing wide area monitoring. So far, our GWIN infrastructure has already been completed in Shatin and achieved 90% coverage in the Kowloon East with around a hundred gateways and thousands of live sensors installed. Applications of GWIN include water level monitoring for speedy alert of potential flooding, parking vacancy information for on-street parking spaces monitoring and online propagation, tree management for detecting tree's inclination and health, and hikers information system for assisting hikers in areas with poor cellular coverage. These can all assist to enhance smart city management, all made possible through the provision of this robust, low-cost network backbone. I appeal to the control engineer's imagination to exploit these technologies. I believe much more can be achieved.

Connecting for Greener Buildings locally and globally - RCx

Let's get back to the word "Connect" and may I pose a small challenge to you - can you think of another type of connection which is of equal importance with network connection? I believe that networks merely connecting sensors would serve little purpose if the system cannot solve the problems behind, and the ability to solve problem rest in the ability to connect our great minds. Take for example, we at the EMSD links human connection through trade participation for the control of carbon emissions so as to make our city and the earth greener. At present, buildings account for about 90% of the electricity consumption in Hong Kong, and over 60% of our carbon emissions is attributable to generating electricity for our buildings. To tackle climate change, we team up with energy engineers, building control engineers and property owners to develop ways to achieve greener building control and automation, and one of the major initiatives is the joint promotion of Retro-commissioning (RCx). The government, leading by example, has been widely implementing RCx in over 200 major government buildings since 2019, achieving an average electricity saving of about 5% up to the end of 2021. For the trade, we connect with trade practitioners for capacity building in the industry, raising awareness and promoting actions in enhancing energy efficiency of existing buildings in the private sector. We have provided professional RCx trainings courses for more than 1,200 practitioners with a target of reducing the electricity

consumption of commercial buildings by no less than 30% and that of residential buildings by no less than 20% from the 2015 levels.

To step further, in 2018, we signed a Memorandum of Cooperation with the institutions in Guangdong, Macao, Beijing and Shanghai to enhance sharing and cooperation in RCx. Also, representing Hong Kong in the APEC, we organised the APEC Workshop cum Training on RCx in early January this year, with more than 100 experts from 11 APEC member economies attended. While the EMSD will continue to promote efficient energy use through innovative and intelligent technologies, I believe control engineers would have much role to play not only by applying these technologies to connect sensors, but more importantly, to connect with the community and the trade, and contribute your expertise in combating the climate change.

Artificial Intelligence

Now, let's move to "A". The "A" that I would like to talk about is Artificial Intelligence, or A.I.

AI for Predictive maintenance of E&M equipment

I believe you all agree that the age of predictive maintenance for E&M system has arrived and the core of this ability would no doubt be A.I.. This paradigm shift would have much impact on all fields of engineering. For example, A.I. has already been adopted in escalator monitoring systems for analysing real-time data collected from sensors to monitor abnormal vibrations and mechanical fatigue of critical components of escalators, and machine learning of these data has provided a model for the early detection and alert of developing defects, resulting in improvement on safety of escalators. The system is now on trial at escalators installed in shopping malls, MTR stations and footbridges across the city. Apart from A.I. on equipment, my engineer would also share with you in a later session today how the use of A.I., combined with blockchain technology, could revolutionize the record keeping through maintenance logbooks and achieve enhancements in the monitoring of lifts and escalators in Hong Kong.

The EMSD has also established the Regional Digital Control Centre, RDCC. Together with A.I. and big data analytics, the RDCC's ultimate goal is to enhance the operational efficiency and environmental performance of E&M assets in a city-wide scale.

Semantic AI to achieve energy saving

In addition of deploying A.I. for better control of E&M equipment, A.I. can also be used for combating climate change through greener control. EMSD has been exploring the use of semantic A.I., with the experts in the field, to perform prediction modelling in forecasting cooling demand and equipment performance, so as to recommend optimised air-conditioning system setting for energy saving. Instead of constructing a building-specific A.I. model, knowledge graphs and natural language processing (NLP) are utilised to represent the building itself in a machine-readable format, enabling the swift building up of an A.I. model for the building. With this system, experts from different domains such as E&M engineers and data scientists can have a common language to readily understand the building E&M system, and the semantic model of a building can be readily adapted to another building, thereby significantly reduced the time required to optimize the performance of a group of buildings. The first such model was implemented on the chiller control system in West Kowloon Government Offices, and achieved a 99% accuracy in predicting the cooling demand, bringing 10-15% improvement on plant performance, which is very encouraging.

Global AI Challenge

To further unleash the potential of application of A.I. in building E&M installations, EMSD and Guangdong Provincial Association for Science and Technology (廣東省科學技術協會) have jointly kicked off the "Global AI Challenge for Building E&M Facilities" last year. The campaign first started with an international conference held in October 2021, with over 2 000 joining online. It was followed by an international competition focusing on A.I.'s applications in the building services sector in late 2021 with over 100 teams enrolled. The result of the competition would be announced in a month or two. I am excited to see our participants' brilliant ideas in pushing our forefront in A.I. application.

It is obvious that the possibility brought by the use of A.I. is boundless. But at the end of the day, even with the most powerful A.I. engines, we still need the even more powerful human

brains to identify the problem and devise the best use of A.I. to tackle it, and that's when engineering knowledge and engineer sense come in. Having this great tool in our arsenal and with the solid training and skills possessed by engineers, I believe control engineers' role would be indispensable in managing the change brought by the A.I..

INNOVATE

Last but not the least, I would like to talk about the “I” – which stands for innovation. If “Connect” is the action to take to face the change and “A.I.” as our tool to deal with the change, then the ability and willingness to innovate would be the mindset to support the two in the change. To demonstrate the importance of this mindset, I would like to share our experience on tackling challenges arising from changes using innovation.

Innovation in Tackling Epidemic & Enhancing Public Services

As I mentioned before, the epidemic has greatly changed the way of our living, and brought numerous challenges to our daily lives and works. Throughout the past two years when the epidemic lingered, the EMSD has been providing I&T solutions to safeguard citizen's health and living quality. For instance, EMSD, in collaboration with the Hospital Authority and the industry, designed from scratch a Mobile Modular High Efficiency Particulate Arrestance Units (Mobile HEPA Units) in a short time for converting general wards into second-tier negative pressure wards, and also we deployed fever screening robots, sterilisation robots and delivery robots for various uses in the period. Riding on this development, we continued our innovative mindset in developing robotic cleaning for toilet bowls to improve public toilet hygiene. The toilet bowl cleaning robot applies image analytics to analyse the cleanliness inside the toilet bowl for determining the optimal cleaning mode before conducting the cleaning, such that the risk of exposure of the toilet attendants can be minimised. In the near future, we hope that the robot would be equipped with an automatic guided vehicle to realise full automation in toilet bowl cleaning. I have this brief video to demonstrate the idea for you.

Innovation in Solar Map

We are also keen to promote the notion of Green I&T, and the “Solar Irradiation Map” project is a good example. In order to facilitate the public to estimate the solar energy potential of their building rooftops and in turn encourage more participation to the feed-in-

tariff scheme, EMSD engaged the Hong Kong Polytechnic University to develop an interactive Solar Irradiation Map. The Map makes use of airborne Light Detection and Ranging, or LiDAR in short, to produce high-resolution contour image of building rooftops with a very high accuracy, so accurate that the map can factor in roof slope and shading effect from nearby buildings, just like the animation that you can see on the screen. By that, the map can provide an accurate estimation of the solar power generation capacity for any given roof-top in Hong Kong.

Innovation Culture

Apart from shaping innovative ideas and innovative projects, we believe it is most important to shape an innovative culture. As the Government's Innovation Facilitator, EMSD launched the "E&M InnoPortal" in 2018 to facilitate matching of pain-points and needs of the Government with I&T solutions from start-ups and research and development institutes. Up to now, there are over 900 I&T solutions, over 350 I&T wishes and over 150 matched I&T projects. Furthermore, we cultivate an innovation and collaboration culture within our organisation. For example, we organize the annual InnoChallenge, where staff can propose their I&T projects and winners would be allocated additional resources to conduct Proof-of-concept trials. Being the third round since 2018, the recent round of InnoChallenge has attracted over 180 I&T proposals. All of these applications and promotions have greatly boosted the innovative mindset of our team, and I encourage all of you to uphold the same innovative spirit, which would be most useful for combating challenges arising from changes.

Concluding Remarks

In closing, I would like to express my sincere thanks to the HKIE CAI Division for hosting this meaningful Summit. 「知否世事常變，變幻原是永恆」 - let's not forget change is eternal, and to face the ever changing world, I encourage control engineers to actively manage the changes and equip ourselves with the ability to adapt, survive and thrive. I also hope my bold interpretation of C.A.I. could inspire you all to take on and control the challenges brought by technological change and climate change, by taking the extra step to enhancing system or human connections, by harnessing the power of technologies such as A.I., and by having an innovative mindset open to the endless possibilities. Every change is an opportunity to make things better, and I am confident that control engineers can lead us grasp these opportunities for the betterment of mankind. Finally, I wish the HKIE CAD

Summit 2022 a great success and fruitful sharing of the speakers in the sessions ahead. Thank you very much.