HKIS Annual Conference 2021 – Surveying into the New Reality
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Transformation from 3D to 4D and more

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Good afternoon, distinguished guests, ladies and gentleman.

Opening

It is my great pleasure to share with you on EMSD's vision on Surveying into the New Reality in this dedicated session.

Introduction

First of all, I would like to express my sincere gratitude to the Hong Kong Institute of Surveyors for making this conference possible in a hybrid mode amidst the pandemic. Technology not only connects us from different places for work or business conferences, but also brings us novel experiences in travelling despite the restrictions from the COVID-19. We can experience the best views around the world by using interactive virtual reality technology. The 360 degrees 3D image provides a realistic visual effect as if we have been teleported to the places of desire without the cost and time for transportation. Not to mention the stress from suffering jet lag.

In a conventional sense, drawing a 3D image starts from a single point. Points join together to become a line, and this becomes the 1D dimension. An array of lines forms a 2D plane. Planes can also join together to form a 3D volume.

In modern practice, the surveying industry creates 3D models using tools such as the 3D laser scanning with unmanned aerial system and 3D mapping photogrammetry. The 3D scanned spatial data are actually made up of points, known as point clouds, and are used to create 3D maps, which significantly contributes to the development of Hong Kong as a Smart City.

- ***Data***

The E&M world is also committed to the advancement of a Smart City alongside

surveyors. Let me draw an analogy between the E&M world and the 3D map. Similar to Euclidean geometry, the E&M world forms the 3D foundation from "data", which is analogous to "dots" in the 3D world.

Every day, in over 8,000 government buildings, tremendous amounts of operational data of systems such as air-conditioning, electrical, mechanical, fire services, and electronic systems are collected by sensors and meters. The collected data, including cooling temperature, water flow rate, electric current, and miscellaneous operating parameters, are stored in local monitoring systems, forming the "dots" on the map.

- ***2D – Data Link (IoT+ LoRa) and Data Collection (GWIN)***

IoT + LoRa & GWIN

Real-time data collection has become achievable in the era of internet-of-things.

Each "dot" is connected to the EMSD headquarters via a data link such as LoRa, which is Long-range data transmission in short. Lora, together with low power IoT sensors, can reduce the cost, time and complexity of installation work for data collection. Each data link is analogous to the 1D "line" in the 3D world.

These individual data transmission links form a 2-dimensional mesh of data network known as the Government-Wide IoT Network (GWIN). GWIN is a territory-wide government IoT platform for centralized data monitoring and analysis and IoT application development. The mesh of data link is analogous to the 2D "plane" in the 3D world.

Since 2019, EMSD has been contributing to building the GWIN as the backbone to collect big data and promote smart city development. This Government-owned private network supports different types of IoT sensors whilst establishing a prudent and secured communication network without relying on third-party communication services. In addition, we have been continually and extensively deployed integrated Building Management System (iBMS) in government buildings to collect E&M operational data. Based on this foundation, we can easily collect operational data for a broad spectrum of applications. After analysing and diagnosing the data, innovative technology can be adopted, which eventually enhances facility management, energy efficiency and user experience.

- ***3D - Data Lake (RDCC)***

In order to perform data analysis, scattered data collected from systems have to be pooled together to form a data lake. The operational data are interrelated with dynamic relationships that build up the 3-dimensional structure for further applications.

In EMSD, the data lake is materialized in the form of our Regional Digital Control Centre, or RDCC in short. So the data lake is analogous to the 3D "volume" in the 3D world.

RDCC

RDCC enables real-time monitoring and data collection for applications such as facility management, predictive maintenance, operational optimization of plants, etc. in government buildings. To realize the complexity of this 3D model, there is more than 600,000 data collected by RDCC every day or nearly 80,000,000,000 (80 billion) annually.

With a strong data backbone, we can realise building informatics from the digital world. The centre acts as a data hub to integrate various information from different systems. The tool has brought significant benefits, including long-term cost savings in the operation and maintenance throughout the building lifecycle.

- ***4D - Digital Transformation (3 Examples)***

With the seeds we have sown to establish our First D, Second D and Third D for Data, Data Link, Data Network and Data Lake, we have taken a leap to extend our data realm to develop applications for the benefit of the community.

I thereby term the applications as our Fourth D (4D) – Digital Transformation. This digital transformation is one of the key milestones along our digitalization journey. Like the well-known DIKW Pyramid, the building blocks have progressive layers of data, information and knowledge which are looping tightly to each other to finally come out with wisdom on the top. Our Fourth D (4D) is similar to the knowledge layer. In the 4D layer, we have transformed the data and information we have gathered from the 1D, 2D and 3D infrastructures through various remarkable applications.

I am going to show you three examples of our Fourth D (4D) – Digital Transformation. I've termed these examples as RGB in short, just as our primary color.

1. *RDCC → CVC*

The first example is **R**. I have earlier introduced our RDCC in the third D (3D) - Data Storage or Data Lake. Our RDCC development has actually helped us face lots of unforeseeable challenges, especially under the New Norm in the epidemic. RDCC has also left its footprint in the COVID-19 Vaccination Programme. We have set up the RDCC for real-time and remote monitoring of 27 Community Vaccination Centers, named as CVC in short. The CVC command centre can remotely monitor the real time signals, like temperature of medical fridges and various indicative alarms in the CVC venues for pre-fault advance actions in order to assure that vaccines are stored under appropriate conditions. With close remote monitoring, over 8 million doses of vaccine have been administered so far, and not even one dose was wasted due to equipment fault.

2. GWIN → Lunar New Year flower market

The second example is **G.** I have earlier introduced our GWIN in the second D (2D) - Data Collection. EMSD leads or contributes to over 30 initiatives out of the total of 130 initiatives in the Smart City Blueprint for Hong Kong 2.0 released last year, with a view to enhancing city management and people's livelihood. The GWIN is one of those. It serves as a backbone to collect big data for building a smart city.

Take for example, we applied I&T solutions swiftly for the betterment of the community and left our footprints in the Lunar New Year flower markets by deploying a cloud-based IoT Crowd-control Management System. We made use of various sensing technologies for automatic people counting; mobile network and the GWIN infrastructure for data transmission, and cloud computing for data collection and analysis. The system displayed the occupancy of various flower markets on site and off site through the web. The public could plan for their flower shopping to avoid queuing. Effective crowd control was achieved. More than 870,000, or about one-tenth of Hong Kong citizens, attended the event safely. It truly demonstrated our readiness and agility in developing and applying I&T solutions for smart living.

3. BIM-AM → Asset management

The third example is **B.** It is BIM, Building Information Modelling. In parallel with our work on digital monitoring and smart network that I have just gone through, EMSD steps forward to create a smart environment by employing the Building Information Modelling - Asset Management, or BIM-AM in short. It is a platform to facilitate building facility management and maintenance. BIM gives us a 3D digital twin of the building and the

facilities and equipment therein. Through integrating the asset data and their real-time status from the Building Management System (BMS) and IoT sensors, etc., we have an integrated system that we patented it as the BIM-AM. EMSD published the BIM-AM standards and Guidelines in Hong Kong. The system has been implemented in several sites, such as the Zero Carbon Building, the EMSD Headquarters and the West Kowloon Government Office, etc.

The integrated BIM-AM platform connects the virtual digitized asset data of a building with real data from on-site sensors in real time, for the benefits of the property and facility management. For example, in an office building, IoT devices can be installed to monitor the usage of carpark and meeting room. BIM-AM collects useful data for analysis to help enhance facility availability, better optimize the use of resources and schedule plants for maintenance. The overall operating efficiency is thus enhanced.

Recently, we have integrated BIM-AM with 5G Smart Glasses and Augmented Reality (AR), to further enhance Operation and Maintenance services. With 5G, Smart Glasses and AR technology, the maintenance personnel on site can view the building asset informatics from the BIM-AM, the real-time operation data of an engineering plant, and can even communicate with backend E&M support team for remote technical support. It enables smart maintenance at a totally different level to minimize the impact of equipment failure on public services. Here I am going to show you a video on how it help maintenance personnel in system diagnostics.

- ***5D - Deploying Future for Now [Digital Transformation + AI]***

So far, I have introduced our digitalization journey from the first D to the fourth D. What's next? Nowadays, we are all facing challenges in combating COVID-19. We have been encountering unpredictable situations of all kinds since the outbreak. Fortunately, we have commenced our digital transformation journey ahead of the epidemic and stayed vibrant in the field, so that we have more I&T solutions, at least they are nearly ready, than problems, to adapt to this new normal. We have been capable of going far beyond the fourth D and getting to the fifth D, that is "Deploying Future for Now". EMSD drives our way through Artificial Intelligence (AI) and unleashes the potential of smarter applications.

In the coming session, I would like to show you another two examples of "Where A.I. meets E&M".

1. *Where A.I. Meets E&M - Predictive Maintenance*

With A.I., we are capable of predicting things based on trends and historical data. We make use of data collected for predictive maintenance on E&M assets in order to optimise the operation performance of assets. Let's take our frequently used transportation as an example to illustrate this idea. Our most frequently used transportation means is probably the lift. Here we go for an application in real-time lift monitoring.

a. *Lift Application*

A non-intrusive hybrid sensing networking comprising of fibre bragg grating sensors and electronic sensors is used in lift to monitor abnormal vibration and mechanical fatigue of critical components. A.I. and cloud computing technologies are adopted to analyse the data collected from the sensors. Also, real-time electric current signals of traction motor, brake coil, and safety circuit of the lift, as well as real-time speed signals of the lift car, are monitored and analysed to identify characteristics and signatures of different faults through deep learning models. Furthermore, the real-time lift monitoring system can be linked up to a mobile application for information sharing with the maintenance contractor. All these non-intrusive data analytics systems can provide early warning and formulate predictive maintenance solutions, thus improving service quality, reliability and safety of the lifts. Let’s have a look on how we materialize this technology.

b. *Electrical Installation Application*

The application of fibre optic can also be extended to monitor the real-time temperature of the bus bar in electrical switchboards, in which potential faults are not clearly visible.

The fibre optic temperature sensing system provides significant advantages over traditional thermal imaging. As fibre optic sensors are installed at busbar joints, we can accurately measure small temperature changes, whereas infra-red technology in thermal imaging is hindered by differing emissivities and reflections from surfaces.

The fibre optic temperature sensing system, coupled with AI technology, can help monitor and pinpoint likely electrical fault location by analyzing thermal profiles under different electrical loads and climatic environment to enable early fault detection before failure and facilitating predictive maintenance, thereby ensuring the reliability of the electricity supply and distribution network.

All the above data analytics inventions are now patented and have been recognised with several Gold and Silver Awards at the International Exhibition of Inventions of Geneva earlier this year.

2. Where A.I. Meets E&M - Building Semantic Artificial Intelligence

Apart from predictive maintenance, let me introduce another example of "Where A.I. meets E&M". Here I will focus on the building informatics.

Artificial Intelligence (A.I.) is no longer something in science fiction but actually comes into place and will be dominant in every part of our future. Building E&M industry will not be the exception. To deploy future for now, we have developed a new A.I. methodology, known as Semantic A.I., to perform big data processing and analytics. Developed by the EMSD together with experts in the field, Semantic A.I. is used to perform big data analysis, including forecasting building cooling demand, equipment performance analysis and trending, and recommending the optimized settings and operational modes and combinations for energy saving. Let's watch a video for a brief idea on Semantic A.I..

Semantic A.I. is a brand-new approach of using graphic ontology to describe building components and the relationships among them. It represents buildings as directly labeled graphs using the Resource Description Framework (RDF) data model; it describes the relationship between spaces, equipment, sensors, data and etc; and it makes building and its systems machine readable. A.I. model developed on specific building can now be shared across buildings, from buildings to a region, and from regions to a city scale. A ten to fifteen percent improvement in plant performance has been materialized through our trial in a Government Office.

With its promising performance, research and development will continue together with the experts around the world. In particular, EMSD together with the Guangdong Provincial Association for Science and Technology is now organising the "Global AI Challenge for Building E&M facilities" with a series of international conference and AI competition commencing from October to the early half of 2022. The objective is to promote AI application on building E&M facilities, which echoes with our sharing in today's conference. I believe it may be of your interest to you as well.

With A.I., the potential of many smart applications would become unlimited. We keep

on exploring more cutting edge technologies for our clients and the community. We will not stop at 5D, and more Ds will be unleashed and discovered in the years to come.

Ending

Jack Ma, an entrepreneur and the co-founder of Alibaba, once said "For most people, seeing is believing. People like us, we believe, and then we will see." We shall join hands to master our smart living with co-imagination, co-innovation and co-creation.

Last but not least, I would like to thank the Hong Kong Institute of Surveyor for hosting this conference, as well as everyone taking part in this extraordinary event. I wish you the very best for a successful conference today and look forward to seeing more collaborated innovative ideas after the sharing by fellow speakers on the surveying into the new reality. Thank you.