THE HONG KONG INSTITUTE OF SURVEYORS
LAND SURVEYING DIVISION
RESEARCH REPORT

Position of Professional Land Surveyor in BIM Workflow

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List of Abbreviations

Abbreviations	Meaning
2D	2 Dimensional
3D	3 Dimensional
3DSD	3 Dimensional Spatial Data
4D	4 Dimensional
5D	5 Dimensional
6D	6 Dimensional
AEC	Architecture, Engineering & Construction
AECO	Architecture, Engineering, Construction and Owner-operated
AI	Artificial Intelligence
AM	Asset Management
AR	Augmented Reality
BD	Buildings Department
BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Methodology
CAD	Computer-Aided Design
CDE	Common Data Environment
CEDD	Civil Engineering and Development Department
CIC	Construction Industry Council
CIOB	The Chartered Institute of Building
CITF	Construction Innovation & Technology Fund
COBIE	Construction Operations Building Information Exchange
CSDI	Common Spatial Data Infrastructure
DSD	Drainage Services Department
DTM	Digital Terrain Model
E&M	Electrical and Mechanical
FM	Facilities Management
GIS	Geographic Information System
HKDI	Hong Kong Design Institute
HKIES	The Hong Kong Institution of Engineering Surveyors
HKU	The Hong Kong University
HKU SPACE	HKU School of Professional and Continuing Education
UST	The Hong Kong University of Science and Technology
IFC	Industry Foundation Classes
IVE	Hong Kong Institute of Vocational Education
IMU	Inertial Measurement Unit
IoT	Internet of Things
IPD	Integrated Project Delivery
LEED	Leadership in Energy and Environmental Design
LiDAR	Light Detection And Ranging
MES	Manufacturing Execution System
MEP	Mechanical, Electrical and Plumbing
ML	Machine Learning
MMS	Mobile Mapping System

PolyU	The Hong Kong Polytechnic University
QAQC	Quality Assurance and Quality Control
QS	Quantity Surveyors
QF	Qualification Framework
QTO	Quantity take-offs
RICS	The Royal Institution of Chartered Surveyors
SLAM	Simultaneous Localization and Mapping
UAV	Unmanned Aerial Vehicle
VDC	Virtual Design and Construction
VIS	Visual Inertial System
VR	Virtual Reality
VTC	Vocational Training Council
WSD	Water Supplies Department

Table of Content

1. Project Background

As Development Bureau (Works Branch) issued a Technical Circular about the adoption of Building Information Modelling (BIM) for capital works projects in Hong Kong starting from 01 Jan 2018. Local construction industry has entered the BIM era for a couple of years (Development Bureau, 2017). It was also mentioned in the 2017 policy address (HKSAR Government, 2017). 20 BIM Uses were mentioned in the Technical Circular (Works) in two classes: Mandatory BIM Use or Optional BIM Use (Development Bureau, 2019). Those BIM Uses will change rapidly in future.

BIM Uses

Works Departments adopts the stipulated mandatory BIM uses in respective stages of a project (Development Bureau, 2019). Works Departments may adopt the optional BIM uses when necessary (Development Bureau, 2019).

	BIM Use	**Investigation, Feasibility and Planning**	**Design**	**Construction**
1	Design Authoring	M[h]	M	M
2	Design Reviews	M[h]	M	M
3	Existing Conditions Modelling	M[i]	M	M
4	Site Analysis	M[i]	M	
5	3D Coordination		M	M
6	Cost Estimation	O	M[a]	M[b]
7	Engineering Analysis		O	O
8	Facility Energy Analysis		O	O
9	Sustainability Evaluation	O	M[j]	M[j]
10	Space Programming	O	M[c]	
11	Phase Planning (4D Modelling)		M[d]	M
12	Digital Fabrication		M[k]	M[e]
13	Site Utilization Planning			M[f]
14	3D Control and Planning			O
15	As-Built Modelling			M
16	Project Systems Analysis			O
17	Maintenance Scheduling			M[g]
18	Space Management and Tracking			O
19	Asset Management			O
20	Drawing Generation (Drawing Production)		M	M

Legend:

M – Mandatory BIM Use for the mentioned stage, including that carried forward from previous stage.

O – Optional BIM Use

Notes:
a. Mandatory for project cost budgeting, project cost control and cost evaluation on design options, etc. at design stage as far as practicable.
b. Mandatory for project cost control, cost evaluation on variation of works, cash flow/spending analysis, etc. at construction stage as far as practicable.
c. Mandatory for checking client spatial requirements such as compliance with the approved schedule of accommodations, reference plot ratio for building projects and site coverage of greenery for building projects, or other spatial requirements relevant to building/civil projects as considered appropriate.
d. Mandatory for the construction activities with very high to extreme risk level identified from the Systematic Risk Management (SRM) according to ETWB TC(W) No. 6/2005 or other activities as considered appropriate at design stage.
e. Mandatory for digitalizing the construction details in the BIM model for mass customized components such as metal cladding, acoustic panels, building façade panels, ceiling panels, acoustic barriers, metal structural members, etc. which are of large quantities and variety in dimensions, shapes, geometries, etc. and modular construction units3 .
f. Mandatory for the construction activities with very high to extreme risk level identified from the SRM according to ETWB TC(W) No. 6/2005 or other activities as considered appropriate at construction stage.
g. Mandatory for providing maintenance attributes for facility structures, fabrics and equipment in the as-built models as considered appropriate.
h. Mandatory for developing/reviewing digital 3D design scheme for a new construction project after TFS has been approved by the WB of DEVB.
i. Mandatory for collecting sufficient and necessary existing site conditions as far as practicable to develop the design scheme and conduct the site analysis for new construction projects.
j. Mandatory for building projects which aim to obtain the Gold or above rating of "BEAM Plus NB 2.0" certification with credit(s) for "BIM Integration".
k. Mandatory for modular construction units including those for MiC, DfMA, prefabrication of BS/MEP installations as appropriate.

Application of BIM (such as 3D Control and Planning, As-Built Modelling, and Space Management and Tracking) is now not only applicable for and focus on design stage but also being implemented during construction stage and even further extending to facilities management stage. Role of professionals such as architects, structural engineers, quantity surveyors and MEP professionals who have been participated in capital works projects, are clear in the workflow of BIM. However, the role and functions of professional land surveyors in BIM workflow either have not been clearly identified or signified, even they have been heavily involved in various capital works in the past decades.

A land surveyor participates from start to end in any major construction project. In the start of the construction, a land surveyor needs to capture initial survey data and engineering planning and analysis. In the progress of construction, a land surveyor records and check every stage of the design steps. In the end of construction, a land surveyor needs to provide as-built survey. In fulfilling the role of a land surveyor in construction industry, BIM technology has come into daily practices. This research aims to investigate and explore the role and function of Professional Land Surveyors under the BIM (Building Information Modeling) Workflow in construction industry in Hong Kong.

2. Project Objectives and Methodology

2.1. Project Objectives

BIM technology has technical common area with our spatial technology in GIS and 3D modelling. This study collects current land surveying operational information like the formation of survey grade 3D modelling, scanning and point clouds, 3D software platforms including GIS and 3D CAD drawings, and the current BIM software platform. The comparison and analysis give information on the technological development path for land surveying professionals.

A BIM educational and vocational training path study is identified. The undergrad and graduate course contents provided by the Department of Land Surveying and Geo Informatics of the Hong Kong Polytechnic University are shown and interviews with the academic staff arranged.

Other general BIM education paths would be visited including software vendors like Autodesk and Bentley Systems, and educational vocational institutes like CIC and IVE. The existing training paths would be inspected and check if the contents are relating and suitable in land surveying perspectives.

The working directions of this research project are:
(a) Application: report the current BIM applications in the land surveying industry.
(b) Development: point out possible future developments important to the land surveying industry.
(c) Technical Requirement: list some commonly used BIM hardware and software.
(d) Available Resources: introduce resources (such as courses) available for land surveyors to equip BIM knowledge and technique.

2.2. Methodology

We had interviews with different leading practitioners in the land surveying industry, including the Government sector (Sr Ricky LAI, Senior Land Surveyor / Building Information Modelling at Civil Engineering and Development Department), consultant (Sr Yvonne CHEU, Technical Director at AECOM Asia Company Limited), construction contractor (Michael WONG, Head of Survey at Leighton Contractors (Asia) Limited, land surveying firm (Sr LAM Lit-yin, General Manager at D-reality Consultancy Limited), and academic institution (Lee Yuen Fai, Lecturer of Department of Construction, Hong Kong Institute of Vocational Education, Morrison Hill). The information provided by interviewees were authorized for academic research. These information included current BIM applications in the land surveying industry, the possible future developments, commonly used BIM hardware and software, and the resources (such as courses) available for land surveyors to equip BIM knowledge and technique.

The following discussion contains the 4 working directions. Each working direction involves the view by 4 practitioners (the Government sector, consultant, construction contractor, and land surveying firm). In addition, the content of training class of Hong Kong Alliance of Built Asset & Environment Information Management Associations (HKABAEIMA) Training Centre is extracted for explanation of Technical Requirement.

3. Application

Currently, BIM is gaining much significance in the land surveying industry as it fosters societal collaboration for smarter information management across built asset and environment. It also enables full benefits from digital ways of working in the built asset industry. BIM applications in land surveying industry are discussed as follows:

3.1 Perspective of the Government sector

Participation of Land surveyor on BIM application

The role of land surveyor does not only focus on data capture, but also BIM data management. Land surveyor is experienced on GIS analysis and management. Those experience can be applied on BIM data management which is an essential part of construction life cycle.

A land surveyor directly participates in 2 type of BIM uses, including Existing Conditions Modelling and As-Built Modelling. A land surveyor provides professional service in various conditions modellings. In road design, land surveyor observes and conducts survey about the existing environment before design the road. Frontline engineering surveyor is responsible for spatial data capture, such as drawing detailed vendor model by using point cloud. In addition, frontline engineering surveyor is capable on controlling UAV to estimate the volume and change of construction site.

Participation of land surveyor is important in as-built modelling. The contract of Capital works projects requires contractor or consultant to provide as-built survey of Capital works projects. The duration of capital works projects usually varies between 4 to 8 years. BIM model will be used from design stage to asset management. It is important to produce as-built BIM model for maintenance and asset management. The participation of land surveyor is essential, such as reality capture for as-built BIM modelling. Apart from Existing Conditions Modelling and As-Built Modelling, land surveyor can also contribute on design BIM model, Engineering Analysis, and 3D Control and Planning.

In various applications of BIM, as a government perspective, it is of vital importance to have a BIM standardization and data exchange format and regulation established in the industry. Currently, it is the Construction Industry Council which has taken up the role of setting the standards and regulations. Government departments at this stage would refer to CIC for the standardization work progress.

3.2 Perspective of consultant

3.2.1 BIM throughout the construction project life cycle

Land surveying has evolved rapidly over the past decade in response to the new technological advances, such as BIM, Immersive and IoT, GIS and advanced data capture technologies. BIM, as one of the technologies that has changed the construction industry and the workflow, is an essential tool for professionals to improve the construction productivity and the integration across the various disciplines. Land surveyor, being specialized in geospatial data and location, can adopt BIM and GIS technologies in various in construction and other industries efficiently.

In project data collection and review stage, the rise of 3D laser scanning and drones in recent years have simplified and speeded up the entire data capturing process and produced great 3D data for the formation of existing ground models in BIM. Land surveyors are responsible for capturing, processing and handling of spatial data, conversion of data into desirable format and products, such as from point cloud to digital terrain model, and from surface model to contours for easy interpretation by the engineers. Engineers can then review the existing site condition and work out the design options, e.g. site formation design with the calculation of cut and fill volume.

Drone Shooting

Laser Scanning

In a design project, professionals from different disciplines are involved, e.g. civil, structural, MEP, architecture, etc. and are responsible for the BIM model of their own discipline. 3D models of existing site conditions and ground features generated from 3D laser scanning or drones, when incorporated into the design BIM models form all disciplines, will form a robust and comprehensive BIM models for design review, visualisation and optimization, such as clash analysis, which facilitates design coordination and collaboration. Clash analysis allows users to identify both inter-disciplinary and intra-disciplinary clashes in the model. BIM specialists or engineers will then review the clashes and discuss with related parties the feasible design changes to solve the clashes.

Construction is a complicated process which needs thorough consideration. 4D simulation of construction sequence and immersive technology, such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality is becoming a trend for design visualization. The design BIM model is used for forming a 4D simulation to illustrate the construction sequence visually and as a proof of design buildability within tight schedule. BIM can also integrate with immersive technology to provide audiences an immersive experience of the future design during public engagement activities and for conducting safety training to the field staff.

4D Simulation

Immersive Technologies
(VR, AR & Mixed Reality)

When approaching to the operation and maintenance stage, as-built BIM model, GIS, sensors and IoT are integrated together to form a geospatial facility management system on an integrated platform. An as-built BIM model records every detail of the assets and facilities, not only the location but also the attributes, e.g. the dimension, serial no., brand name, operation manual, etc. BIM models integrated with IoT therefore provides a valuable source of information for the implementation of the geospatial facility management system. Land surveyors who are familiar with the GIS technology, BIM standard and handling of spatial data can contribute to the data conversion, system integration, and system design and development.

3.2.2 Application Examples

Application in geotechnical works

BIM, together with drone and GIS, can be applied in geotechnical works. Geotechnical engineer collects and provides underground technical data, such as borehole location and the distribution of materials below ground. Land surveyor is responsible for data processing and converting the collected data from to GIS or other formats that are compatible with BIM and forming the underground geology models. Land surveyors also take care of drone surveys to capture the existing site condition in order to generate a digital surface model. The digital surface model of the existing environment is overlaid / incorporated with the underground geology models in GIS/ BIM software, providing a holistic view which helps the investigation of underground geology and the subsequent engineering design.

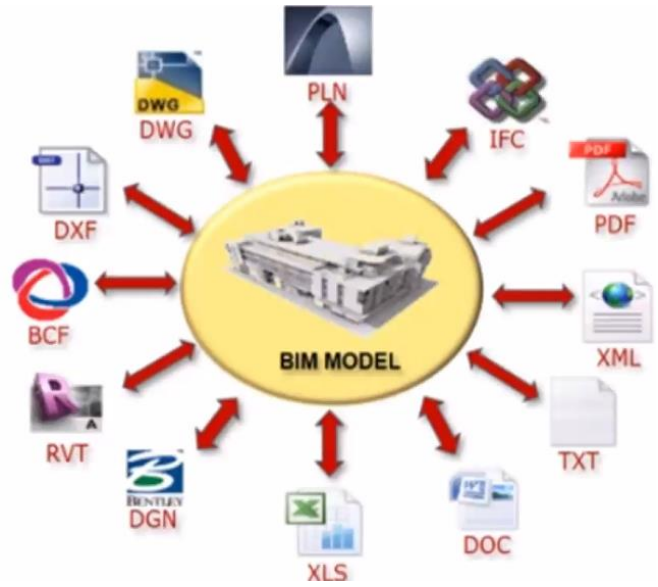
Application in slope works

To facilitate better visualization for inaccessible slopes or remote site, VR technology can be applied for site inspection and presentation. After drone survey, a set of 360-degree panoramas can be produced for making an online interactive virtual tour on the web. Using high-end, computer-connected VR devices, walk-throughs can be developed to view details of the rock outcrop on a cliff on 1:1 scale. The texture and cracks on the rocks can be clearly seen as if on the scene.

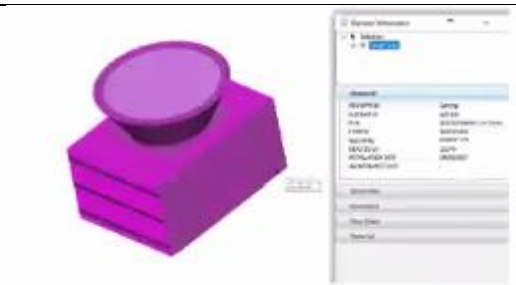
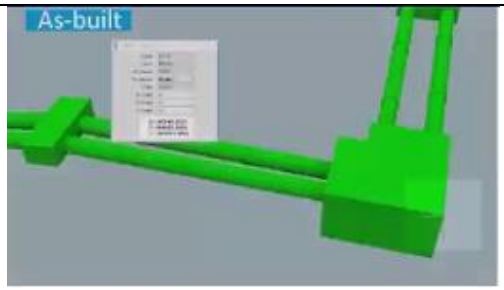
BIM technology is also useful in the design of slope mitigation works. 3D simulation allows visualization of spatial arrangement of slope mitigation works options, such as soil nails arrangement, flexible barrier and man-made slope design, with the surrounding environment and enables clash detection for design review. It also empowers engineers for better decision making and to proceed with an optimal design option and enhances design accuracy and efficiency. The use of BIM technology allows parametric designs which makes design easier and response to design changes faster. 2D views (i.e. section view/ plan view) can be derived from the 3D model and all changes in the 3D model will reflect instantly in the 2D drawings. Therefore, drawing production optimization can be achieved.

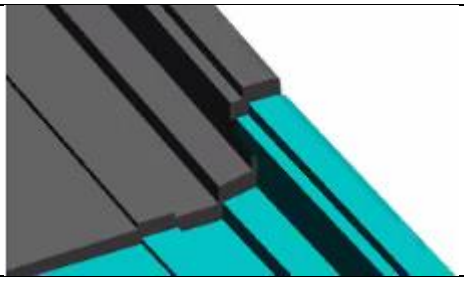
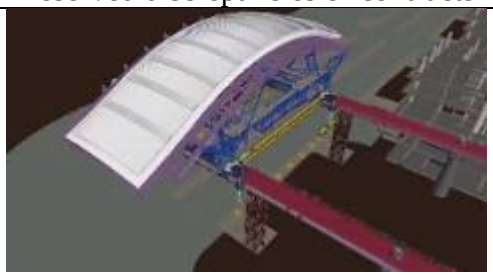
3.3 Perspective of construction contractor

Common Data Environment (CDE) is a mutual platform for better collaboration (Owner, Contractor, Sub-contractor, and Consultant). The automated collaboration solutions minimize the risk of project coordination errors. Aside from it, BIM also supports a wide range of data communication platforms and it is compatible with different file types, such as IFC, DXF-DWG, PDF, XML and Native CAD or BIM file formats, which greatly increase the efficient when dealing with the BIM data as different software can be used.



The construction lifecycle contains the post-design phase, the construction part, and the maintenance stage. For the post-design phase, BIM is useful for the conceptual animation for communication, resolved discrepancies of contracts and bridged design and actual construction; For the construction part, BIM is useful in Simulation for safety and accurate progress, georeferenced for setting out, and pre-case and checking; For the maintenance stage, BIM is useful for handling the as-built spatial data and information, and BIM has its own readily available standard library. The key successful of BIM include its practical insights, geographic information-rich, spatial awareness and building geometry. These characteristics allow BIM could establish a library of standard assets and solve discrepancies over pre-construction condition (e.g. discrepancies between contracts). Also, BIM can utilize intelligent survey 3D modelling and 3D print model, which allow a better cross-disciplinary communication and understanding.

	
As-built information	As-built spatial data

	
Resolved discrepancies of contracts	Bridge design and actual construction
	
Stimulation for safety and accurate progress	Georeferenced for setting out

3.4 Perspective of land surveying firm

In the construction process, the role of land surveyor is passive, because land surveyor does not involve a lot in tender stage and design stage. Usually land surveyor starts to involve in site visit and setting out. However, there is a change when BIM is applied in the market: When client handles tender model (preliminary design model) in tender stage, they need initial survey data (for, say, existing condition model), so they need to adopt laser scanning, photogrammetry, and topographic feature to generate point cloud and produce and/or verify tender model. Therefore, land surveyor starts to involve in tender stage.

There is change of role of land surveyor in construction process. In tender stage, construction company needs the help of land surveyor to produce initial survey data (existing condition model), but there are lots of non-surveying companies which provide laser scanning and UAV survey at the same time. This circumstance already existed in the market. Overall, land surveyor will involve more in construction process due to point cloud processing and 3D model processing.

Rarely contractors apply BIM in construction process. Contractor and sub-contractor now still have limited BIM capacity. Even though there is BIM application, it is applied on quarterly or half year process review. Usually the BIM model is updated quarterly or half year, and if the process is strictly controlled, land surveyor or land survey team are required to start as-built survey to update BIM model, and to conduct quality check survey. BIM will be the new tool instead of CAD in the quality check and/or as-built survey in future.

It is rarely to find as-built survey check quarterly, because it depends on "BIMer" and land surveyor team capacity.

BIM application (such as BIM model update) in, for instance, West Kowloon Cultural District depends on the coordination of main contractor and West Kowloon Cultural District Authority. Some of the frontline sub-contractors also involve in BIM application in West Kowloon Cultural District, such as Electricity and Mechanics (E&M) sector. Asset Management / Facilities Management (AM/FM) apply BIM (such as as-built BIM model) on E&M session. Architecture session would apply BIM to check the original design and the finalized design. Structural sub-contractor (such as erect formwork sector and steel bending sector) seldom apply BIM technology.

4. Development

Point out possible future developments important to the land surveying industry.

4.1 Perspective of the Government sector

In the past of engineering surveying, topographic survey acts the function of 3D surveying. By using BIM technology, the design of 3D model can fulfill BIM use, such as using and vectorizing point cloud to convert spatial feature to 3D model. BIM uses can extend from maintenance and asset management to costing if BIM user requirement or standard can be established. Therefore, the concept of "object" is important in BIM modelling, such as objectrise and featurerise, that means the process does not limit to vectorize point cloud to form 3D geometry only.

Recently, the Government aims at standardization and focuses on establishment of BIM requirement, such as BIM modelling methodology, which can exert BIM uses. In the example of road construction, CAD will be adopted to produce 3D plug (sectional object) per unit. By calculation per unit, the budget will be estimated.

Object types are released by CIC, and it will be more in the future. Apart from BIM object guide, CIC released BIM library. The construction industry and the Government engineering departments produce object to CIC for share use. Building, factory, and EMP involve more objects in BIM, but civil works involve less objects in BIM.

In the Capital works of CEDD, survey division of CEDD and other Government departments are building up BIM object library. Objects in the BIM object library can be shared among different departments, so there is no duplicate object.

CIC published standard and guideline in different field. CIC is trying to develop ISO 19650 (BIM standardization). The Government will publish general standard soon and will try to cooperate with the general standard by CIC. The Government also will establish the common standard for inter-department usage. In the project of New Development Area (Kwu Tung North and Fanling North), CEDD launches the pilot BIM adoption scheme. The project involves the cooperation between CEDD, Electrical and Mechanical Services Department (EMSD), Buildings Department (BD), Drainage Services Department (DSD), and Water Supplies Department (WSD). By the inter-department project, the Government can establish the common guideline and standard.

The Government applies BIM for several years, and each department develops its own system. Although CIC published BIM general standard, it is necessary to have a more detailed and specific standard in the actual practice. The Government takes CIC BIM standard as a framework to establish the BIM standard among each department. Each department will share the common standard and align a general framework which can be adopted in the construction industry in the future.

Apart from the local example of BIM standardization, the international example of BIM standardization is about BuildingSMART International. It is an international organization which creates and develops open digital ways of working for built asset environment (Building

SMART International, 2020). It also publishes Industry Foundation Classes (IFC) which helps asset owners and the entire supply chain work more efficiently and collaboratively through the entire project and asset lifecycle. It encourages open BIM which can facilitate data exchange.

The Government not only focuses on BIM standardization, but also facilitates data exchange. The Government firstly establish BIM standard and guideline for construction in Hong Kong, then the Government establish open standard for data sharing.

GeoBIM is the integration of BIM and GIS. Common Data Environment (CDE) is the GIS platform which shares and reuses BIM resources. Lands Department is responsible to manage the platform by using GIS method. Open BIM format will be the format for data exchange, build up 3D GIS, and convert to City GML. It means land surveyor can contribute their profession by GIS experience. Survey and Mapping Office is responsible to produce 3D smart City Model and referencing system. The aim of the integration of BIM and GIS is to produce digital twin platform (4D) which is an integration of 3D smart city and time. The demand of the data volume of digital twin platform is high, because it involves the data collected from different time. BIM is related with GSDI platform.

4.2 Perspective of consultant

There are technology advancements (hardware and software) in surveying or 3D data collection. For instance, land surveyors can use Unmanned Aerial Vehicle (UAV) / drone, Vehicle and Backpack Mobile Mapping System (MMS) and terrestrial and handheld laser scanning to carry out surveying works. All these technologies enhance and foster the development of 3D digital mapping.

Unmanned Aerial Vehicle (UAV)

Vehicle/ Backpack
Mobile Mapping System (MMS)

Terrestrial Laser Scanning

Handheld Laser Scanning

Currently, Lands Department of HKSAR, is preparing a set of 3D Spatial Data (3DSD) to put forward the 3D digital mapping era. 3DSD is a set of territory-wide digital 3D model data created to represent the shape, appearance and position of various types of ground features, including building, infrastructure and terrain of Hong Kong. 3DSD in 3DS, MAX and VRML format and is available for purchase in the Lands Department. The data can be used in applications such as analysis, visualization and presentation in carrying out technical study or public consultation for land development and infrastructure construction projects. With the technology advancements, 3DSD is enhanced in a way that photorealistic mesh models of the city are generated with street view images captured by vehicle-based mobile mapping system together with aerial view images.

Besides, the Innovation and Technology Bureau published the Smart City Blueprint for Hong Kong in December 2017 setting out the overall framework and strategy for developing Hong Kong into a Smart City, including Common Spatial Data Infrastructure (CSDI), 3D Map and BIM. In the 2017/2018 Policy Address, it promoted the establishment of CSDI, actively sought to require consultants and contractors to use BIM technology and announced the implementation of open data policy.

It is envisioned that BIM will be widely adopted in building and infrastructure projects in both private and public sectors. The BIM data can therefore be formed a valuable data source and the integration of BIM and GIS is an increasingly important area for development and maintenance of 3DSD. In support of the smart city development and to ensure smooth integration of the BIM data with the 3DSD, land surveyors in engaged to carry out a study on the integration of BIM data and 3DSD with the purpose to create a BIM-friendly data environment to facilitate data sharing and also the works and land development processes. 3D spatial data standards to be followed by works departments in collecting and storing BIM data required for the integration of 3DSD were defined. International standards were studied, adopted and modified to fit Hong Kong's situation. An as-built/ simplified BIM Data Repository was set up and new BIM compliant data formats, e.g. simplified BIM, simplified FBX, for 3D Spatial Data will be released.

Once the 3D spatial data covering the whole city of Hong Kong is available, they can be used in conjunction with BIM models of future designs and forms a holistic and realistic 3D representation of the future scene, enabling the carrying out of a more accurate planning related analysis by GIS and is beneficial to presentation of the project to the clients. This forms part of the 3D digital city which supports the development of a common spatial data infrastructure and facilitates data sharing and implementation of the open data policy.

These advances provide a better experience and results for the industry and clients, and the job is continuing to change as new and improved technology is made available each year. By integrating the advanced technologies, the industry will move on a path towards excellence.

4.3 Perspective of construction contractor

BIM will be getting more popular among the land surveying industry as BIM is beneficial to the whole progress, and there are numerous advantages of using BIM. For instance, BIM allows early discovery and solutions to mistakes and less remedial work, it can also enhance safety, promote productivity, develop accuracy, improve quality, and allow a more efficient communication between the client and contractor/consultant, sub-contractor, and supply chain.

Different techniques will be used together in order to generate a more precise survey data. For instance, the application of UAV (drone) and 3D Reality modelling. In this application, the 3D spatial data and object condition are both recorded, and it combines oblique aerial and close-range photos with geo-referenced in HK1980 Grid Coordinate System, which enables the production of a precise 3D model of the construction site.

As-built model can also combine with the 3D Reality Model and Point Cloud Model by measuring the slot hole location from 3D Reality Model by ContextCapture. This application allows a comparison with design for cladding installation. A more precise result can be produced if the Point Cloud Model of laser scanning and UAV of Mega Column are combined.

UAV model overlaying with the design model is also an application of BIM. This application is ideal for rebar modelling, clash analysis and problem solving with associated parties. By overlaying the design model and existing features, it also allows the pre-analysis for any potential clashes and provide a realistic progress monitoring, which streamline the whole process and it can save time for the project.

4.4 Perspective of land surveying firm

In engineering projects, a land surveyor is responsible for the acquiring and production of the geo-spatial information such that the as-built point cloud matches the site environment in a required accuracy. Thus, it is suggested that a land surveyor should be the professional who endorses the spatial elements in the as-built BIM project.

For example, in Singapore, a registered land surveyor is responsible to endorse the coordinates information in a project. The law ensures that a licensed land surveyor has a legal status and a specified professional role in any land and engineering projects which involves spatial information. BIM is of course one of them.

It is suggested that BIM training can be provided by HKIES (The Hong Kong Institution of Engineering Surveyors) to cultivate a BIM surveyor. In the future development, it is important to cultivate BIM survey to handle different BIM projects. For land surveying firm, BIM surveyor is a specialist in the land survey division.

5. Technical Requirement

List some popular BIM hardware and software.

The following hardware and software are the trend of BIM application.

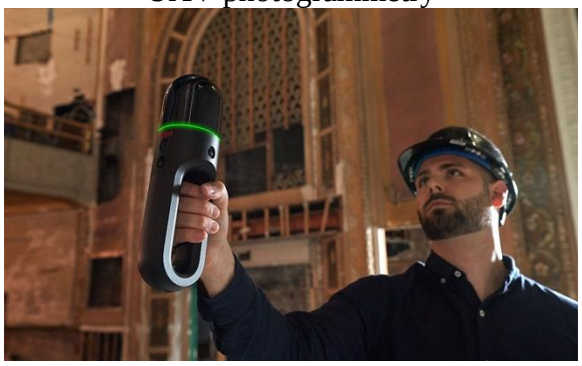
5.1 Hardware

Hardware for 3D digital survey such as UAV photogrammetry, laser scanner, and handheld scanner.

Total station

UAV photogrammetry

Static Laser scanner



Handheld Scanner

In traditional construction cycle, surveyors will use the total station to obtain the data and convert the data to 2D data such as record survey plan and topographic plan. Due to the improvement of the technologies, drone, laser scanner and LiDAR techniques are used by the surveyors to carry out data collection, and these technologies are useful in generating the 3D pointcloud model and 3D BIM.

It is available for land surveyors to use, for example, Trimble's Total station as BIM hardware. Setting out data and spatial as-built data from total station can be exported to online BIM platform. By retrieving the data from cloud and downloading to total station, the latest BIM model could assist in setting out process. In addition, structural sub-contractor rarely uses BIM, and the level of details of design BIM is not explicit enough, so frontline contractor surveyor is not able to use BIM.

There is preparation for UAV operation, including risk assessment and weather forecast. For risk assessment, first, UAV users need to avoid clash with obstacle, such as tower crane in

construction site. In addition, UAV users need to reduce signal interface, such as the interface from rebar yard in construction site. Moreover, UAV users need to choose safe place and time for take-off and landing; For weather forecast, first, UAV users need to estimate the rain probability to avoid raining if the UAV model is not waterproof. In addition, UAV users need to consider about the maximum of wind speed, such as 20knots (maximum) for DJI Phantom 4 Pro. Moreover, UAV users need to consider about the number of satellites (minimum 8 required) for the location of UAV.

Static Laser Scanner can capture the reality by 360 degree. Each point in a given scan is the same coordinate system. The accuracy level is mm level which is suitable for high accuracy requirement project.

Static Laser Scanner involves registration, which is the process of merging together one or more scans by using targets, point cloud data, or a combination of both.

In order to cover the area, several setups of stations of Static Laser Scanner are required. Target based method is that Static Laser Scanner will scan the fixed target and receive the signal, then form the model. Cloud based method is that point cloud will be calculated by the algorithm, then feature will be detected and be formed. Static Laser Scanner can adopt both of target based method and cloud based method.

In the pre-registration, Visual Inertial System (VIS) delivers the delta pose between two consecutive setups in real time. VIS is based on 5 cameras and one Inertial Measurement Unit (IMU), which can detect the level and coordinate. The mobile mapping can measure the direction and distance of points. For example, “original” 3D points derived from point cloud. “New” 3D points created by forward intersection from multiple scanner positions, it means VIS can detect the reality feature then calculate the direction and distance of points by using AI.

No user interaction is needed, because Static Laser Scanner automatically start and stop. VIS is robust to most of the handling and environment conditions.

Handheld scanner is suitable for indoor scanning which can facilitate the planning. The accuracy level is cm level. To convert the basic building model without any details, handheld scanner can be used to scan the building by walking through the building. Apart from scanning the indoor environment of the building, handheld scanner can also be used at outdoor environment. The spatial relationship and basic building model can be obtained by scanning different environment such as scanning the indoor car park and outdoor market.

After the scanner scans the environment, the results can be converted into digital by using different software to merge the images obtained from the scanner. Besides, a QAQC report can be obtained after the generation of digital data, this report can show the accuracy of the results. For the usage of the results, it can be shared to different parties for data checking and data enquiries. Also, we can also put the data into other software to carry out the data analysis such as obtaining the digital terrain model, a 3D model or BIM can be generated by using AutoDesk or Bentley. This is useful for data analysis, 3D document and further maintenance or operation.

For the application, it can be applied to the underground utilities such as converting the underground image into the GIS system. Information such as depth of the cables, direction of the utilities and dimension can be obtained. Furthermore, by adding the HK1980 coordinates

system into the data, the coordinates of the utilities can be known.

Handheld scanner involves the Simultaneous Localization And Mapping (SLAM) technology which is a method of measuring the environment an determining a location at the same time. It is usually used with handheld scanner. The GrandSLAM (Simultaneous Localization and Mapping) is a Combination of high-speed dual axis LiDAR, multicamera vision system, and an inertial measurement unit that makes the BLK2GO self-orienting. SLAM Trajectory Mapping is the technology which records the routine and point cloud, then 3D point cloud model is generated.

Leica SLAM can use laser pulse to position the features nearby even when there are lacking light, but the features will lose their true color. To determine and define the features, we can only rely on the intensity of the point.
Software includes Autodesk's and Bentley's products, and photogrammetry and laser scanning software.

5.2 Software

AUTODESK.

Autodesk allows effectively collaborating with the entire project team and pinpoint specific changes as the model gets updated to speed up project delivery and reduce RFIs. It takes advantage of actionable insights to make data-driven decisions to protect against miscommunication, change orders, and schedule delays.

Bentley
Advancing Infrastructure

Bentley provides software to accelerate project delivery and improve asset performance for the infrastructure that sustains economy and environment.

Bentley
CONTEXT CAPTURE

ContextCapture is a software that can create 3D models from simple photographs or point clouds, it is the process of capturing the physical reality of an infrastructure asset, creating a representation of it, and maintaining it through continuous surveys. Bentley's reality modeling software, ContextCapture, provides real-world digital context in the form of a 3D reality mesh.

ArcGIS
ESRI

ArcGIS is a software that can bring the spatial data into a powerful system that geoenables, hosts, and scales. It enables updating and adding to the data without disrupting the maps and apps that use the data. It also allows controlling who adds to and modifies the data.
This software can reveal relationships, identify prime locations, use optimal routes, and analyze patterns to make predictions. Users can add valuable context to the data by combining it with Esri's demographic and lifestyle data.

Revit is one of the software that is popular among the land surveying industry, it provides the function of construction planning, roof coordination, MEP and temporary works. Using Revit can drive efficiency and accuracy across the project lifecycle, from conceptual design, visualization, and analysis to fabrication and construction.

Tekla is a structural BIM software, lets you create, combine, manage and share multi-material 3D models packed with valuable construction information. It is useful for permanent steel truss (pre and non-cambered), temporary steel support and it the export to other file format like ifc format. Tekla can be used throughout the project, from buildings and infrastructure conceptual planning to fabrication, construction and maintenance, for design, detailing and information management.

CATIA software is a multi-platform software suite for computer-aided design (CAD), it is a social design environment built on a single source of truth and accessed through powerful 3D dashboards that drive business intelligence, real-time concurrent design and collaboration across all stakeholders including mobile workers. This software can be used fir glazing and cladding, and it can also export to different file format like stp format.

Navisworks is a software that combine design and construction data into a single model, it can identify and resolve clash and interference problems before construction, and aggregate data from multiple trades to better control outcomes.

Construction

Autodesk Navisworks Freedom

Navisworks Freedom is the viewer for NWD and DWF™ file formats, and it is a visualization tool which provides an overall coordination and collaboration. This software can extend the whole-project view to all project stakeholders, helping to improve communication and collaboration. Multidisciplinary models created in a broad range of applications—including information from Building Information Modeling (BIM), digital prototypes, and process plant design can be combined into a single integrated project model and published into the NWD format using Autodesk Navisworks Manage or Autodesk Navisworks Simulate software.

Construction

Autodesk Navisworks Manage

Navisworks Manage is a comprehensive project review solution that supports coordination, analysis, and communication of design intent and constructability.
Navisworks Manage is useful form steel and cladding interface, clash detection and clash analysis, it can also provide a detail survey checking for complicated steel structure for Roof Truss and Mega Column.

Rhino can create, edit, analyze, document, render, animate, and translate NURBS curves, surfaces, and solids, point clouds, and polygon meshes. Rhino is used in processes of computer-aided design (CAD), computer-aided manufacturing (CAM), rapid prototyping, 3D printing and reverse engineering in industries including architecture and industrial design.

Pix4D's advanced photogrammetry software uses the images captured by drones to generate 3D models and maps, such as professional orthomosaics, point clouds, 3D models and more. The Pix4D programs below are either supplied, or available as options, with most senseFly drone solutions.

PHOTOMODELER

PhotoModeler is a software application that performs image-based modeling and close range stereophotogrammetry – producing 3D models and measurements from photography. The software is used for close-range, aerial and UAV photogrammetry.

CYCLONE

Leica Cyclone is the point cloud processing software. It is a family of software modules that provides the widest set of work process options for 3D laser scanning projects in engineering, surveying, construction and related applications.

FARO SCENE

SCENE software is specifically designed for all Focus and third-party laser scanners. Process and manage scan data efficiently and easily by using real time, on-site registration, automatic object recognition, scan registration, and positioning. Generate high-quality data in full color quickly and conveniently by incorporating images from automated targetless and target-based scan positioning.

6. Available Resources

Introduce resources (such as courses) available for land surveyors to equip BIM knowledge and technique.

6.1 Pre-Approved Lists of Construction Innovation & Technology Fund (CITF)

There are over 100 BIM training courses in Pre-Approved Lists of Construction Innovation & Technology Fund (CITF) (Construction Innovation & Technology Fund, 2020). In order to equip the BIM knowledge and techniques, land surveyors can take the BIM training course to learn the operation of different software such as Revit and Autodesk Navisworks. In the training courses, technical application of BIM in different aspects, Point Cloud to BIM and Scan to BIM will be introduced. The land surveyors who take these courses will be required to carry out coursework and examination to ensure their understanding in BIM software. A certificate will be awarded after the examinees have passed the assessment. Some of the courses can fulfill the requirement of being BIM Modeller and BIM Manager.

Those BIM training courses are provided by 26 different course organizers as below.

Advanced Construction Information Development Ltd

- CEI Basic (Revit)
- CEII Architecture (ArchiCAD)
- CEII Architecture (Revit)
- CEII BIM Model Audit
- CEII Families (Revit)
- CEII Structure (Revit)
- CEII MEP (Revit)
- CEII Multi-disciplinary Collaboration
- CEIII Architecture
- CEIII BIM Management
- CEIII Cost Management
- CEIII Construction Management
- CEIII GBP Submission (Revit)
- CEIII Structure
- CEIII Structural Submission (Revit)
- CEIII MEP

Asian Institute of Built Environment

- Building Information Modeling (BIM) – Advanced Workshop
- Building Information Modeling (BIM) - Introductory Course
- Building Information Modeling and Building Services Engineering (BIM & BS introductory Course)
- 24-hr Autodesk Revit BasicTraining Course

BSI Pacific Limited (BSI) & The Department of Real Estate and Construction, Faculty of Architecture, The University of Hong Kong (HKU)

- Global BIM Manager Professional Training (5 days)

Build.IT Ltd.

- Level I BIM Training for Basic Revit

- Level I Brief Introduction for BIM Concept Training
- Level II BIM 360 Training – Glue and Build
- Level II Revit Architecture 2018 Training
- Level II Revit Structure 2018 Training
- Level II Revit MEP 2018 Training
- Level III BIM Management / BIM Execution Plan / BIM NEC Training
- Build.IT BIM Management / NEC / CDE Training Services (B3002)
- Professional Certificate Programme in Civil and Infrastructure BIM (Integrated/Comprehensive)
- Professional Training Course for Civil and Infrastructure BIM - Geotechnical Engineering
- Professional Training Course for Civil and Infrastructure BIM – Earthworks
- Professional Training Course for Civil and Infrastructure BIM – Underground Utilities
- Professional Training Course for Civil and Infrastructure BIM - Highway Structure
- Professional Training Course for Civil and Infrastructure BIM – Structural Reinforcement
  Professional Training Course for Civil and Infrastructure BIM - Civil 3D for Combined Service Drawings

Building Information Technology Limited

- Building Information Modelling - Revit - Basic Modelling – Architecture
- Building Information Modelling - Revit - Advance Modelling – Architecture
- Building Information Modelling - Revit - General Building Plan Statutory Calculation – Architecture
- Building Information Modelling - Revit - General Building Plan Drawing Production – Architecture

Continuing Professional Education Limited

- Autodesk Advanced Certificate in BIM Revit Architecture
- Autodesk Advanced Certificate in BIM Revit Structure
- Autodesk Advanced Certificate in BIM Revit MEP
- Autodesk Advanced Revit BIM Training Course for Building Services Engineers
- Autodesk Certificate in BIM Revit MEP
- Autodesk Civil 3D Professional Course – Highways
- Autodesk Civil 3D Professional Course – Survey
- Autodesk Civil 3D Professional Course - Drainage and Utilities
- Autodesk Revit BIM Training Course for Architects
- Autodesk Revit BIM Training Course for Structural Engineers
- Autodesk Revit BIM Training Course for Building Services Engineers-Basic
- Building Information Modelling (BIM) - Cubicost TRB (Basic)
- Building Information Modelling (BIM) - Cubicost TRB (Advanced)
- Building Information Modelling (BIM) - MagiCAD Ventilation
- Building Information Modelling (BIM) - MagiCAD Piping
- Building Information Modelling (BIM) - MagiCAD Electrical
- Building Information Modelling (BIM) - Cubicost TME (Basic)
- Building Information Modelling (BIM) - Cubicost TME (Advanced)
- Building Information Modelling (BIM) - Cubicost TAS (Basic)
- Building Information Modelling (BIM) - Cubicost TAS (Advanced)

D-Reality Consultancy Limited

- HKIES Accredited BIM Training Level 1 (Revit) (CITF-PBT19-024)
- HKIES Accredited BIM Training Level 1 (Civil3D) (CITF-PBT19-057)
- HKIES Accredited BIM Training Level 1 (AECOSim) (CITF-PBT19-058)
- Point Cloud checks BIM (VTB) (CITF-PBT18-028)

- Point Cloud to BIM (ETB) (CITF-PBT18-029)
- Scan to BIM (STB) for manager (CITF-PBT18-030)

(HKIES means The Hong Kong Institution of Engineering Surveyors)

Forida Limited

- Autodesk Navisworks Manage Training
- Autodesk Revit Architecture Basic Training
- Autodesk Revit MEP Training
- Autodesk Revit Structure Training

BIM Introduction Workshop

Form.Welkin Ltd.

- Advanced Certificate in BIM Analysis with Navisworks
- Advanced Certificate in Revit MEP
- Advanced Certificate in Revit Structure
- BIM for the Construction Managers
- BIM Fundamental with DIM & CDE
- BIM Project implementation Practice
- BIM Project Integration with SketchUp, Sefaira & Trimble Connect
- Civil 3D Certified Professional practice workshop
- Revit Architecture Certified Professional practice workshop
- Revit MEP Mechanical Certified Professional practice workshop
- Revit Structure Certified Professional practice workshop
- Quality & Contractual Control in BIM Projects

Global Virtual Design and Construction Limited

- Open BIM Training
- 4D BIM Scheduling and Process Management
- 5DBIM Quantity Take-Off

Hong Kong Design Institute, PEEC

- Autodesk Revit Architecture Fundamentals
- BIM Professional Certificate

Hong Kong Institute of Construction

- Building Information Modelling (BIM) Advanced Modelling (Civil) – Civil 3D (B3DZ)
- Building Information Modelling (BIM) Advanced Modelling (Civil) – Civil 3D (B3EZ)
- Building Information Modelling (BIM) Course (Design, Analysis, Construction Management and Collaboration) - Fuzor (BFDZ)
- Building Information Modelling (BIM) Course (Design, Analysis, Construction Management and Collaboration) - Fuzor (BFEZ)
- Building Information Modelling (BIM) Course - Navisworks (BNDZ)
- Building Information Modelling (BIM) Course - Navisworks (BNEZ)
- Professional Certificate for Building Information Modelling (BIM) Manager (BMFZ)
- Professional Certificate for Building Information Modelling (BIM) Manager (BMNZ)

Hong Kong Institute of Construction (Construction Industry Council)

- Building Information Modelling (BIM) Advanced Modelling Course (Architecture) – Revit (BIBZ)
- Building Information Modelling (BIM) Advanced Modelling Course (Architecture) – Revit (BIAZ)

- Building Information Modelling (BIM) Advanced Modelling Course (MEP) – Revit (BIDZ)
- Building Information Modelling (BIM) Advanced Modelling Course (MEP) – Revit (BIEZ)
- Building Information Modelling (BIM) Advanced Modelling Course (Structure) – Revit (BICZ)
- Building Information Modelling (BIM) Advanced Modelling Course (Structure) – Revit (BISZ)
- Building Information Modelling (BIM) Basic Modelling Course – ArchiCAD (BMAZ)
- Building Information Modelling (BIM) Basic Modelling Course – ArchiCAD (BAEZ)
- Building Information Modelling (BIM) Basic Modelling Course – Revit (BRDZ)
- Building Information Modelling (BIM) Basic Modelling Course – Revit (BIMZ)
- Building Information Modelling (BIM) Basic Modelling Course (Civil) – Bentley (BCBZ)
- Building Information Modelling (BIM) Basic Modelling Course (Civil) - Civil 3D (BCDZ)
- Building Information Modelling (BIM) Basic Modelling Course (Civil) - Civil 3D (BCEZ)
- Building Information Modelling (BIM) Objects Development Course (BODZ)
- Building Information Modelling (BIM) Objects Development Course (BOEZ)
- Certificate in Building Information Modelling (BIM) Data Management with Dynamo (BDAZ)
- Certificate in Building Information Modelling (BIM) Data Management with Dynamo (BDPZ)

HKU SPACE

- Certificate in Building Information Modelling (BIM)
- Strategic Application of Building Info. Modeling (BIM) in Architecture and Project Management
- Technical Application of Building Information Modeling (BIM) in Architecture and Project Management

isBIM Limited

- BIM001 Revit BIM Training Course for Architects
- BIM002 Revit BIM Training Course for Structural Engineers
- BIM003 Revit BIM Training Course for Building Services Engineers
- BIM004 Revit BIM Training Course for Builders
- BIM005 Introductory Revit BIM Training Course for Project Managers
- BIM010 Navisworks Manage Training Course for Project Planners
- BIM011 Navisworks Manage Training Course for Project Managers

Lodco Creative Centre Limited

- Point Cloud for Surveyor
- Conceptual Training for Surveyor
- Introductory Workshop for Surveyor on Site Scanning
- Scan Directly to Indoors to BIM
- Scan to 3D Printing

MES Services Limited

- 5DBIM/ QIM Training 3

Professional Education and Engagement Centre (PEEC) of Hong Kong Design Institute (HKDI)

- BIM Theory and Principle
- Autodesk Revit Architecture Advanced
- Certificate in Revit Level 1

School of Continuing and Professional Studies, The Chinese University of Hong Kong

- Building Information Modeling (BIM) in Architectural Design and Project Management
- Fundamentals of Building Information Modeling (BIM) for Engineers and Project Managers

SGS Hong Kong Ltd.

- BIM Modelling Practical Course - Basic Level
- BIM Practitioner (Arch. & Struct.) Intermediate Level
- BIM Practitioner-Mechanical, Electrical and Plumbling (MEP) Training Course (Intermediate Level)
- Introduction of BIM for Project Leader and Project Manager

Spatial Technology Ltd.

- BIM Adoption in Government Project (ST-CIC-01)
- Fundamentals on BIM Project (ST-CIC-02)
- Introduction to BIM in Bridge Design (ST-CIC-03)
- Introduction to BIM in Road Design (ST-CIC-05)
- Introduction to BIM in Site Formation (ST-CIC-04)
- Introduction to BIM in Tunnel Design (ST-CIC-06)
- Introduction to BIM in Underground Utility (STCIC-07)
- Revit Fundamental (Introduction and Architectural Modeling)
- Revit Fundamental (Structural Modeling)
- Revit Fundamental (MEP Modeling)
- Revit Fundamental (Revit Families) (ST-CIC-RE-04)
- Revit Fundamental (Revit Families) (ST-CIC-RE-05)
- Revit Fundamental (Naviswork)

The Earth Solutions Ltd.

- Civil BIM Basic - MicroStation for Civil: Basic
- Civil BIM Advance - OpenRoads Designer for Civil

The Hong Kong Institute of Architects X Hong Kong Design Institute

- BIM in Architectural Design

Vircon Limited

- BIM Modelling Practical Course – Basic Level
- BIM Object Creation Course (Intermediate Level)
- BIM Practitioner (Arch. & Struct) Intermediate Level Skill
- BIM Practitioner (Civil) Intermediate Level
- BIM Practitioner-Mechanical, Electrical and Plumbing (MEP) Training Course (Intermediate Level)
- BIM Software Practical Course - Fuzor (Basic Level)
- Dynamo from Basic to Practical (Advance Level)
- Introduction of BIM for Project Leader and Project Manager

Vocational Training Council

- BIM 5D Basic Training Course
- BIM ArchiCAD Advanced Course
- BIM ArchiCAD Basic Training Course
- BIM Certified Expert Level I Basic Training Course
- BIM Certified Expert Level II Architecture Training Course
- BIM Certified Expert Level II MEP Training Course
- BIM Certified Expert Level II Structure Training Course

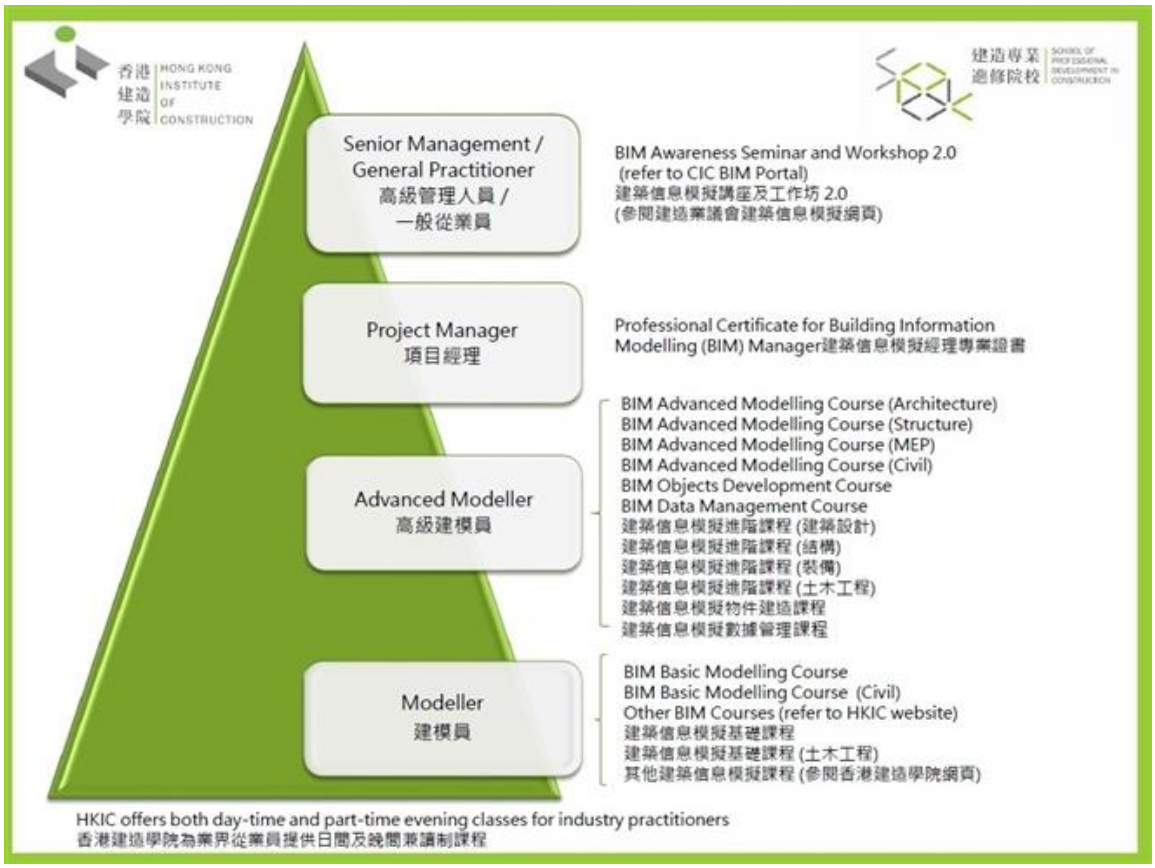
- Introductory Workshop on Building Information Modelling (BIM) for Management
- Professional Certificate in Building Information Modeling (Building Works) (EG424115P)
- Workshop on Terrestial Scanning (1819)
- Workshop on Virtual Design Construction - Fuzor (1818)

Welkin Computer Training

- Certificate in BIM Civil Engineering Design with Autodesk Civil 3D
- Certificate in BIM Design with Autodesk Revit

6.2 Construction Industry Council (CIC)

Construction Industry Council provides 15 BIM related courses as below (Construction Industry Council, 2020). Senior management/ General Practitioner, Project Manager, Advanced Modeller, and Modeller can take courses respectively by following:



For Senior management/ General Practitioner:

- BIM Awareness Seminar and Workshop 2.0 (refer to CIC BIM Portal)

Project Manager:

- Professional Certificate for Building Information Modelling (BIM) Manager

Advanced Modeller:

- BIM Advanced Modelling Course (Architecture) - Revit
- BIM Advanced Modelling Course (Structure) – Revit
- BIM Advanced Modelling Course (MEP) – Revit
- BIM Advanced Modelling (Civil) - Civil 3D
- BIM Objects Development Course
- BIM Data Management Course

Modeller:

- BIM Basic Modelling Course – ArchiCAD
- BIM Basic Modelling Course (Civil) – Bentley
- BIM Basic Modelling Course (Civil) - Civil 3D
- BIM Basic Modelling Course - Revit

Others:

- BIM Course (Design, Analysis, Construction Management and Collaboration) – Fuzor
- BIM Course – Navisworks
- Certificate in Building Information Modelling (BIM) Data Management with Dynamo

6.3 UGC-funded Program

Bachelor of Science (Honours) in Land Surveying and Geo-Informatics of The Hong Kong Polytechnic University provides 5 BIM related subjects as below (The Hong Kong Polytechnic University, 2020).

LSGI2294A - Computer Aided Drafting and Computation for Geomatics
Content: Apply 3D drawing skill to create 3D BIM model (20%)
Details: Ten weeks will be spent at Industrial Centre in practical classes on AutoCAD and BIM software and will focus on building design.

LSGI3242A - Digital Terrain Modelling
Content: Integrate BIM 3D model with DTM for 3D visualization and clash detection (less than 10%)
Details:
BIM and DTM integration:
Practical works consist in compare BIM with DTM, Geo-referencing building information, clash detection and view extraction

LSGI2222A - Fundamentals of Geographic Information Science
Content: Data Modeling and Representation for Buildings (BIM)
Details:
- Basic concepts about modeling of building and building components;
- Solid model vs surface model;
- Attribution of building components.

LSGI4103A - Geomatics Project Management
Content:
Understand the importance of building information modelling(BIM) in the modern construction industry
Details:
a)Building Information Modeling (BIM) technologies and standards
- BIM standard development in Hong Kong and worldwide
- IFC, CityGML and other exchange standard and platform
- Levels of BIM
- Multi-dimensional BIM: 3D, 4D, 5D …

b)Building Information Modeling (BIM) as a project management tool
- Interoperability among service providers in a construction project
- BIM model for project management and environmental impact analysis
- Legal and policy issues

LSGI2280A - Mapping
Content: Introduction the basic of BIM
Details:

- SDI and BIM Basic concepts of SDI and BIM
- Importance of SDI and BIM for modern urban development and construction

6.4 Non-UGC funded Program

Higher Diploma in Architectural Technology and Design of Vocational Training Council provides 3 BIM related subjects as below (Vocational Training Council, 2020).

Core Module:
-Building Information Modelling

Elective Module:
-BIM for Building Services
- Advanced Building Information Modelling

Master of Science in integrated Project Delivery of The University of Hong Kong provides 6 BIM related subjects as below (The University of Hong Kong, 2020). It is professionally accredited by The Chartered Institute of Building (CIOB) and The Royal Institution of Chartered Surveyors (RICS) and professional accreditation will be sought from the Construction Industry Council (CIC-Accredited BIM Manager Course). This program is suitable for land surveyors who want to increase Qualification Framework (QF) levels and receive knowledge of new technologies.

- Strategic technology management, developing skills in the management of BIM, GIS, IoT, AI/ML, VR/AR, gaming technologies, Blockchain, VDC and IPD
- Change management in organisations and projects
- Team building, collaborative design and construction project management
- Understanding and managing interdisciplinary and cross-cultural differences in teams
- Understanding the lifecycle BIM management experiences and best practices to the Architecture, Engineering, Construction and Owner-operated (AECO) industry
• Broaden their global horizon regarding the innovation and contextualising BIM and digital built into the sector

Certificate in Building Information Modelling (BIM) of HKU School of Professional and Continuing Education provides 6 BIM related subjects as below (HKU School of Professional and Continuing Education, 2020). The Certificate in Building Information Modelling (BIM) is accredited by the Hong Kong institute of Building Information Modelling (HKIBIM) as fulfilling the academic requirement of its Associate Membership.

- Introduction to BIM
- BIM General Practice
- BIM Coordination
- BIM Practice for Architecture
- BIM Practice for Structure
- BIM Practice for Building Services

Postgraduate Diploma and Master of Science Programs in Civil Infrastructural Engineering and Management of The Hong Kong University of Science and Technology provides 1 BIM related course as below (The Hong Kong University of Science and Technology, 2020).

Core Module:

CIEM 5170 Building Information Modeling and Smart Construction

Higher Diploma in Architectural Technology and Design of Hong Kong Institute of Vocational Education provides 3 BIM related subjects as below (Vocational Training Council, 2020).

Core Module:
-Building Information Modelling

Elective Module:
-Advanced Building Information Modelling
-BIM for Building Services

Hong Kong Institute of Vocational Education provides 10 BIM related courses as below (Vocational Training Council, 2020).

Professional Certificate in Building Information Modelling (Building Works) provides 5 BIM related subjects as below.
Core Module:
- CON4095X - Building Information Modelling Basic
- CON4099X - Building Information Modelling for Construction Management

Elective Module:
- CON4096X - Building Information Modelling- Architecture
- CON4097X - Building Information Modelling- Structure
- CON4098X - Building Information Modelling- Building Services

Building Information Modelling (BIM) ArchiCAD Basic Training Course provides the course contents as below.
- The global BIM concept
- The ArchiCAD Interface
- Create a site model using mesh tool
- Slabs, columns, stairs, roofs, curtain walls, GDL Objects, dimensioning and etc.
- Create Stories, floor plans, sections and elevation Views, 3D documents, visualization, layout, rendering and exporting documentation.

Building Information Modelling (BIM) ArchiCAD Basic Training Course provides the course contents as below.
- Overview BIM
- Application and development of BIM in HK and the world
- Case studies to demonstrate the following: Enhance design communication, Synchronize documentation, Improve spatial coordination, Extract date from BIM.
- BIM Workflow & staffing
- Concept of BIM project execution plan

Certificate in Building Information Modelling (Facility Management) provides 2 BIM related subjects as below.

CON4095X Building Information Modelling Basic
-Concepts of BIM
-Parametric BIM modelling Basic

-Basic BIM projects

CON4140X Building Information Modelling for Facility Management
-Architectural and Structural modelling
-Mechanical, Electrical and Plumbing (MEP) modelling
-BIM FM applications
-BIM Execution / Implementation plan for facility management

Building Information Modelling (BIM) 5D Basic Training Course provides the course contents as below.
- Introduction of 5D BIM
- Standard Method of Measurement and BIM Measurement
- Hands-on exercise of BIM Quantity Take Off process
- Introduce objects parameters and definitions
- Creation of schedule

Building Information Modelling (BIM) ArchiCAD Advanced Training Course provides the course contents as below.
- Create the building envelope, modelling site, structure, openings, stairs, foundations, zones, dimensions
- GDL Objects, adding libraries, furniture and equipments
- Details and Schedules
- Documentation and setting up views and Rendering
- Sharing your design, exporting 2d information and BIM based Documentation
- Revision management using Issues and Changes Data
- Teamwork and BIM Server management

Certificate in Building Information Modelling (Project Management) provides the course contents as below.
CON4142X Building Information Modelling Project Management
-Concepts of BIM
-BIM Software and Upcoming Technologies
-BIM Project Processes and Implementation
-Roles and Responsibilities Associated with BIM
-Contract Issue

Building Information Modelling (BIM) Cost Management Course provides the course contents as below.
- Introduction of BIM for Quantity Surveying
- BIM QTO – Basic skills
- BIM QTO – Structure elements
- BIM QTO – Advanced Structural
- BIM QTO – MEP elements
- BIM QTO – Architectural elements
- Quantitative Information Modelling
- 4D Construction
- 5D Construction
- Change Management

Certificate in Building Information Modelling (Quantity Surveying) provides the course contents as below.
CON4095X Building Information Modelling Basic
-Concepts of BIM
-Parametric BIM modelling Basic
-Basic BIM projects

CON4139X Building Information Modelling Cost Management
-Introduction BIM for Quantity Surveying
-BIM QTO
-Quantitative Information Modelling (QIM)
-4D Construction
-5D Construction

CON4141X Building Information Modelling Contract Administration
-BIM Environment
-Roles and Responsibilities Associated with BIM
-Contract Issue

Building Information Modelling (BIM) ArchiCAD Basic Training Course provides the course contents as below.
- The global BIM concept
- The ArchiCAD Interface
- Create a site model using mesh tool
- Slabs, columns, stairs, roofs, curtain walls, GDL Objects, dimensioning and etc.
- Create Stories, floor plans, sections and elevation

Views, 3D documents, visualization, layout, rendering and exporting documentation.

Hong Kong Design Institute (HKDI) provides 4 BIM related courses as below (Vocational Training Council, 2020).

Professional Diploma in Building Information Modelling (Architectural Studies) provides 3 BIM related subjects as below.
Certificate in BIM Fundamentals (AIP4057Y)
Certificate in BIM and Collaboration (AIP4058Y)
Certificate in BIM Management (AIP4059Y)

Certificate in BIM Fundamentals provides the course contents as below.
- Interpret the theory and principles of BIM implementation
- BIM Management, stages, PAS 1192, COBIE
- Use of advanced Revit (BIM Software) techniques in architectural cases
- Creating models, BIM contents and massing
- Use of Revit Structure, MEP, facility management and energy analysis

Certificate in BIM and Collaboration provides the course contents as below.
- Methodology for collaborative BIM
- Analysing cross-disciplinary projects
- Use of 4D, 5D and 6D technology in Revit
- Revit MEP: utility creation, electrics, content editing
- Revit Structure: framing, specification, material editing, calculation, analysis and rebar

Certificate in BIM Management provides the course contents as below.
- Navisworks: 4D construction sequences, clash collision, reporting
- Analyse the advantages and limitations of architectural projects with software
- Use of Energy Analysis Tools (Sefaira/Cloud) for QS, LEED and BREEAM
- Analyse perspectives of project specifications and risk management in BIM through real-life case studies
- Automation via parametric modelling and computational design

Building Information Modeling (BIM) in Architectural Design and Project Management by The School of Continuing and Professional Studies of The Chinese University of Hong Kong provides the course contents as below (The School of Continuing and Professional Studies of The Chinese University of Hong Kong, 2020).

- BIM basics;
- Benefits of BIM in AEC industries;
- BIM in building design and work processes;
- BIM and project management;
- BIM standards in Hong Kong;
- Prefabrication and logistics and supply chain management.

7. Conclusion

With references to the experiences of BIM adoption and participations of the construction industries, BIM data sharing among different stakeholders, e.g. consultants and contractors, and along whole construction project life cycle from design stage until maintenance stage, e.g. developer and property management agent, are the hot topics in the promotion and adoption of BIM in recent years. Hong Kong Government endeavors to motivate and strengthen the adoption of the BIM in construction industry by regular updating the Technical Circulars in BIM adoption for Capital Projects for Works Department to follow. It is envisaged that BIM adoption will be mandatory requirement in more and more government construction projects as well as private projects in near future.

In addition to align with the BIM adoption in Hong Kong, keeping abreast with the latest development of BIM and BIM related technologies in other countries is recommended.

The focus of BIM technology adoption is different between the construction industry and the Government: The construction industry is passionate to apply new technology on BIM development, such as drone shooting, laser scanning, and Common Data Environment. BIM not only enhances level of details of modelling, but also enhances work efficiency; The Government focuses more on formulating strategy in BIM adoption, standardization and data sharing. The Government emphasizes the methodology of modelling, related standard, and openBIM for easy sharing. [CYY(1]

The Government has established BIM object library for data sharing and is going to form GeoBIM (integration of BIM and GIS). The Government refers to the standard by CIC, then it will publish the common standard which is suitable for the construction industry in Hong Kong. [CYY(2]

With the rapid development and adoption of BIM, it is anticipated that the application of BIM will be extended to other industry, in addition to construction industry. Under the trend of BIM application, it is recommended for land surveyors to equip BIM knowledge to follow the rapid BIM technology and construction industry development. CITF, CIC, HKU, HKU SPACE, HKUST, HKDI, IVE, VTC, and PolyU provide different BIM programs. Some of the courses can fulfill the requirement of being BIM Modeller and BIM Manager. Land surveyors can apply those programs based on working needs.

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