buildingSMART International (2022)
386-Construction Buildings Construction for Buildings using openBIM

The Henderson - an “Office for the Future”

OyejVDKa

Entrant details

Role or Job Title on the Project	Senior BIM Engineer
Employer	
Hip Hing Construction Co., Ltd, Hong Kong, China	
Employer Role	Construction, Fabrication or Supply Chain Company
Are you or your employer a member of buildingSMART?	Yes - Chapter Member

Entry details

Entry Details

By checking this box I understand and acknowledge that this awards program is to assess information about openBIM, and that openBIM is not only about the use of solutions. openBIM is about setting up an environment where every party in a team can work in the optimal way ("how they prefer") without putting limitations on others. It is about freedom to take control over your data and workflows, while keeping that freedom for others as well. Full use of open standards is not mandatory for this mission.	✓
Website	https://www.thehenderson.com.hk/

Location

The Henderson is located at 2 Murray Road, Central, the heart of Central Business District in Hong Kong. It occupies 2,880-square-meter site area, and will be developed into a 465,000-square-foot (GFA), 190-metre tall super Grade-A office tower, with 36 stories (including ground floor) and 5 basement floors. The land price reaches HKD 50,000 per square-foot, which smashed the world record then in year 2017.

Submitting Party and Stakeholder Logos (compiled into one .ppt/pptx file for upload)

PPTX	The Henderson_01_Stakehol... (575 KiB download)

Entry Description

General Description

Located in the heart of Hong Kong's central business district, the architecture of this 34-storey office tower is designed to be an "Office for the Future", with its base elevated above the ground to shelter communal courtyards and gardens. Structurally, the architecture mimics the form of a Bauhinia bud about to blossom. Featured on the Hong Kong flag, Bauhinia's 5-petal flower is deeply symbolic for local residents. Creating new civic spaces enveloped by nature, the redevelopment connects adjacent public gardens and parks, with these outdoor spaces flowing seamlessly into indoor areas. Echoing the nature theme is a lush landscaped podium built to also serve as a pedestrian hub with elevated public walkways connecting the CBD and Admiralty.

The Henderson owes its striking presence to a curvaceous glass façade designed by the London-based Zaha Hadid Architects, creating a stark contrast with other sober architectural marvels nearby, including Pei's BOC Tower, Foster's HSBC headquarters and Rudolf's Lippo Centre. With its high-tensile steel structure, the Tower can cater for an extraordinary wide span light-filled column-free open office in its floor plans, which offers flexibility and a new level of collaboration possibilities for tenants to be adaptable to the ever-changing operational needs for a top-notch Grade A office. A top-down construction method is employed to speed up the re-development programme by proceeding the 5-storey deep basement and 36-storey from ground construction in parallel. Not only is the Office Tower a sculpture in itself, adding to the beauty of Hong Kong's skyline, but it also aims to be a healthy, resilient, smart, green and sustainable building of world-class standards. This Tower will be truly unique and cutting-edge in many ways, tailor-made to be an exemplary Grade A Office for the coming generation and beyond.

Goals

Interoperability

OpenBIM provides a framework for interoperable data exchange between software. IFC provides freedom on software choice, which enables purpose-driven software adoption, and therefore ensuring model maturity and granularity. This is especially important in this project, due to the atypical design and vast early fabrication involvement. High model maturity makes coordination for fabrication and early issue detection possible, facilitating excellent engineering solutions, such as, preload ELS struts, and improved steel-rebar interfacing configuration, etc.

Moreover, interoperability opens up infinite opportunities for further analyses, which used to be limited due to incompatibility of proprietary software. In our project, models from 5 native design-authoring software could be exported under IFC framework to a wide array of software for further analyses, such as normalization for unprecedented façade geometry, CFD for atypical plant room, and prototyping for underslung mullion joint with sprinklers, etc. Furthermore, ad-hoc analysis due to change in client requirement can also be accommodated, by IFC-compliant software. Such flexibility leverages the capability of each software and unleashes the limits of BIM applications.

Traceability

Embracing an ambitious project goal, the Henderson is designed by international architects, and it involves specialized project parties adopting numerous software and practice. In contrast to model development and analysis, a single source of truth in terms of coordination issues is particularly important during coordination in this complex project. BCF provides a light-weight and cross-platform issue exchange and tracking solution. Adopting a BCF-centered issue management workflow,

our project team can manage to use multiple specialized software (Navisworks, Dalux, Trimble Connect, Solibri) corresponding to different types of coordination, without the risk of creating difficulties of issue tracking.

Reliability
BIM Execution Plan and ISO 19650 govern the information management process and production standard amid different practices and interpretation on BIM in this international project context. The international standard ensures data standardization, which opens up the possibility of rule-based checking, such as the use of Solibri.

In terms of software level information exchange, this project upholds software adoption principle that fulfills IDM and MVD certification of IFC and BCF. Interoperability is more than the ability to open a certain file format in a software, it is about the data exchange between software. Adopting openBIM software with IDM and MVD in this project, all BIM user can master the quality of data input and output during exchange. This is especially important for data sensitive analysis in this project, such as parametric façade design and DfMA. Only when the data quality in data exchange is clearly defined, BIM users can be sure that the data for analysis is fit for purpose.

Sustainability
With interoperable, traceable and reliable data, a sustainable digital twin follows. The adoption of OpenBIM framework ensures that data in this project is interoperable across software and trade, and along project cycle. Extending from the openBIM framework, COBie will be referenced as an exchangeable schema between BIM and FM tools, which ensures sustainability of information management, and provides a solid foundation for the establishment of smart building that aims to sustain for over 50 years.

Achievements
Design
De-risk - Spatial coordination completed 2-weeks before steel fabrication
Detailing - Integrated BIM in LOD-G-400 achieved before MEP fixing
Space - Office headroom maximized by incorporating 90% MEP routings into Steel Framing Zone.
Optimize - Generative design rationalized 30% façade panels
Automate - Automated model checking and headroom demarcation reduced workload into a few minutes.

Procure
Plan – Early openBIM phase planning gives evidence to 7-day steel-installation cycle and top-down construction approach
Cost – Quantity take-off from Revit or Trimble Connect via open format saves 25% time from manual labour
Report – OpenBIM for steel enables engineers to weekly illustrate installation progress directly in CDE

Assemble
Façade – Digitalized over 4000 façade panels including conical or double-curved panels for precast
Steel – Digitalized over 16,000 tons of steel for pre-fabrication
Optioneering – Buildability study via openBIM finally trims 45% time for basement capping beam installation, and saves 80% steel for underslung support

Operate
Maturity - Over 20 organizations participate in openBIM. Site workers are trained to view BIM via smartphones on-site
Maintainable – Maintenance access are openly-coordinated in CDE before site installation
Quality – Steel installation quality guaranteed via 3D-laser scanning on-site against BIM model.
Sustainable – Under progressive agreement of COBie methodology, asset value will eventually be brought to operation stage.

What stage of completion is the entry content representing?	Construction stage in progress

Stakeholder Statements

Project Objectives
Upholding the vision of an “Icon Amongst Icons”, The Henderson tower aims to create an urban oasis in the central business

district. The objective of the Project includes sculpting and materializing an unprecedented architectural design, optimizing functional space and skyline view, and providing an internationally qualified green and high performance building for occupants and the neighborhood. All objectives are driven by innovative technologies, engineering excellence and openBIM software, and practically implemented by a project team with a wealth of knowledge of openBIM and information management.

The following summarizes highlights in this project.

Design: Unprecedented Architectural Masterpiece Realized by Technical Excellence
The entrance creates a civic plaza to be enveloped by nature, with its base elevated above the ground to shelter communal courtyards and green gardens. The tower presents layering of a blossoming bauhinia, which employs highly non-uniform shape of façade. The office interior comprises high-tensile steel structure to provide an extraordinary wide span (up to 26m), with 5-metre floor-to-floor height, to maximize functional flexibility with natural lit. The rooftop Banquet Hall offers panoramic views of the city skyline, which is designed to become one of the city's most memorable venues with its glazed roof and façade. The masterpiece design brings unprecedented challenges for coordination, procurement and manufacturing to surmount.

Moreover, being designed with a deep basement to fulfil car-parking demands, whilst constrained by congested site with sensitive live tunnels in close proximity, the project is constructed with a top-down construction approach, which adds challenges in construction planning

Procure: Full Life-Cycle OpenBIM Information Management
The solution to all technical challenges requires early involvement among a wide array of project parties, highly specialized in their trade with their own tools. With the involvement of more than 20 OpenBIM parties and 15 proprietary BIM software, there is a need to ensure data interoperability during coordination among such wide specialties while not compromising the native data framework and solution of each specialty. This can only be achieved by information management using openBIM approach.

Assemble: Design for Manufacturing and Assembly (DfMA)
The project of Henderson features more than 60% cylindrical or double curved glass panels, together with the assembly of 16,000 ton of prefabricated steel. Craftsmanship and precision is highly emphasized for such vast amount of prefabrication. This expedites the need for early involvement of a broad range of specialties for coordination. Immersing into openBIM project environment, different project parties can coordinate without resorting to a particular software solution. OpenBIM eventually brings high data integrity for exchange, cost effectiveness, and even the possibility of DfMA using parametric design approaches.

Operate: Innovative Technology empowered by openBIM data
The Henderson aims not only to be aesthetically appealing, but also environmentally friendly and embracing high-performance, by aligning itself with world-class building performance benchmarks with the use of cutting-edge technology.

In material procurement, the project introduces 4-ply, double-laminated, double-curved low-iron, low-e insulated glass unit - the first of their kind in Hong Kong - to effectively insulate the building and reduce its cooling load, and to build resilience in the precision-crafted facade. Besides, project-patented solar responsive ventilator (SRV) is also designed and adopted at perimeter of floors to maintain a comfortable indoor temperature. In technology approach, a contactless circulation concept will be implemented by various IT infrastructures such as AI-assisted lift controls. High-end technology will also be explored through joint corporations with prestigious solution providers, such as Microsoft, in developing an enormous FM portal for future operation.

At present, the design has achieved numerous green certifications at the highest grades. The design, procurement and construction targets full certification at occupancy.

The Henderson looks to the future with the integration of advanced parametric design, novel technologies implementation, challenging construction and smart operational strategies. OpenBIM empowered AIM and the concept of COBie in asset data exchange will definitely accelerate the steps towards final goals.

Upload a 2 minute video to show the scope of the entry.

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openBIM Claim

Detailed description of openBIM used on the project or initiative

OpenBIM is implemented in this project mainly by IFC and BCF, with data exchanged and managed on CDE platform.

IFC
Models from different trades are developed from 5 openBIM compatible software. Model files are exported to IFC format for coordination or further BIM applications (such as rendering and analysis) by different proprietary software.

BCF
Model files exported in IFC format will be imported to various coordination software for design review and verification. Different types of issue detected in respective software will be created and exported via BCF format to BIM Track, which serves as the terminal issue management tool. Taking the advantage of BCF, issues can be tracked and exchanged with integrity regardless of the software from which they originate.

The file exchange via IFC and BCF will be supported by a coordination CDE, Trimble Connect, which serves as a digital twin throughout the project lifecycle.

Applications
Using the IFC framework, the steel model created in Tekla and the reinforced concrete model created in Revit can be exchanged and combined for design review. For example, an alternative design on the capping beams – the primary loading structures for the whole tower- was proposed due to the design review made available by IFC. The revised design provides improvements corresponding to the issues identified in design review, such as insufficient space for rebar fixing and safety concerns.

The IFC environment also enables cross-trade design review on the Excavation & Lateral Support (ELS) works and basement construction. For example, preloaded struts, with their position optimized, are adopted instead of conventional struts in the ELS design, in response to the potential risks of lateral loading against construction sequence, which were identified early in design review with the support of openBIM. Furthermore, the basement model was overlaid with rock contour created in different software, to facilitate design review on excavation scheme, which enables the project team to optimize manhole locations by avoiding excavations in the hard grade III rock layers.

The software-neutral coordination environment enabled by openBIM showcased its essence in pre-fabrication coordination. For instance, the interfacing area between reinforced concrete core and surrounding steel framing elements involves complex and congested rebar-steel beam composite configuration. Therefore, the models must be detail enough for pre-fabrication coordination. Without the IFC framework, model maturity would have been compromised due to compatibility among software.

The openBIM software-neutral platform is also applied for MEP coordination and subsequent associated BIM uses. Base model in Revit, steel model in Tekla, façade models from Rhino, and interior fit-out models from Digital Project and CATIA are exported to IFC for routine coordination. This is especially important in this project due to atypical floor layout and vertical routing configuration. As for plant room, the combined model is exported via IFC to different software for finite energy analysis. In addition to coordination in Navisworks and Trimble Connect, it is exported to Fuzor for simulation and validation of transformer delivery route, and is also exported to ANSYS Fluent for CFD analysis, via the gbXML format.

"We were able to innovate using openBIM."

Generative Design
Featuring a free-form architectural design, this project contains a high variety of façade glass panels. T Generative design is

adopted to rationalize the variety in façade geometry for efficient manufacturing without compromising the architectural form. Design model created in Digital Project and CATIA was exported to Rhino for analysis, using grasshopper. The models after analysis were exported via IFC for interfacing coordination, and also via STP for fabrication. OpenBIM enabled the entire process by providing a software-neutral platform for information exchange with data integrity sufficient for fabrication.

As-built Verification – AR
The adoption of Dalux for AR verification demonstrates project team's initiative in implementing openBIM. Dalux supports import of models created in different design software in IFC format. With its AR capability, site workers can overlay the design model on the built environment via their mobile devices. Issues can be created and exchanged in BCF format for instant review by office staff. These provide a more efficient workflow and intuitive approach for as-built verification.

Automation
Solibri was adopted to validate design models against statutory requirements, by over 20 customized in-house checking rules. Discipline models from various proprietary solutions are imported to Solibri using openBIM framework for automated checking. The issues found in Solibri will be exported via BCF to BIM Track for consolidation with other issues.

Other innovative openBIM uses include Vehicle Path Simulation, DfMA, as-built verification through 3D laser-scanning, Digital Works Supervision System (DWSS), RFID, and IoT smart building systems for operation stage.

openBIM methods used	✓ IFC 2x3 ✓ ifcXML ✓ bSDD ✓ BCF ✓ IDM ✓ mvdXML ✓ COBie
Have you used bSDD to add additional extensions on top of IFC?	No

Were there other regional or open standards used other than those listed above?

Regional BIM
CIC Building Information Modelling Standards General (2019)
CIC Building Information Modelling Standards General (Ver. 2.1, 2021)
EMSD, Building Information Modelling for Asset Management (BIM-AM) Standards and Guidelines (Ver 2.0, 2019)
(Note: CIC stands for Construction Industry Council (Hong Kong); EMSD stands for Electrical and Mechanical Services Department, HKSAR Government)

International BIM
ISO 19650-1; ISO-19650-2 (2018)
ISO 19650-5 (2020)
ISO 19650-4 (2021)
ISO 27001 (2013)
BS 8536-1 Briefing for design and construction. Code of practice for facilities management (Building infrastructure) (2015)
PSU, BIM Project Execution Planning Guide (Ver 2.2, 2019)

OpenBIM
ISO 16739-1 (IFC) (2018)
ISO 10303-21 (Data Exchange of STEP) (2016)
ISO 29481 (IDM) (2010)

Level of Collaboration | ✓ Multi-domain in two or more organizations

Information Requirements

PDF The Henderson_03_Informat... (3.7 MiB download)

openBIM Evidence

Software Ecosystem Map

PDF The Henderson_04_Software... (3.2 MiB download)

Process Maps

PDF The Henderson_05_Process... (1.4 MiB download)

openBIM Data Metrics Summary

PDF The Henderson_06_Data Met... (1.1 MiB download)

Additional openBIM Supporting Evidence

PDF The Henderson_07_Research... (6.4 MiB download)

Lessons Learned

Integrity of Geometry

Free-form geometry is one of the project highlights and challenges. Due to the stability and robustness of IFC2x3 format, it was chosen as the first option for IFC data exchange format in our project. The free-form geometry model created in Rhino was exported to IFC format via a third-party addin since there is no direct export option in Rhino. However, zig-zag edges were observed in free-form geometry in IFC 2x3. It is suspected that the geometry has been triangulated. Considering the final purpose being fabrication and detailed analysis, such distortion would be unfavorable. Therefore, the STEP format, which is designed for manufacturing, was adopted instead of IFC2x3 by fabrication supplier. Although STEP format retains geometry integrity, the consistency of model exchange format will be affected, given IFC2x3 is used in data exchange of other trade models.

Upon further study on IFC-4 Add 2 (4.0.2.0) protocol, it was found that free-form geometry will be expressed via NURBS surface, which would be more accurate and therefore promising for fabrication-related purpose. In the future, preliminary study and trial on exported result of free-form geometry using different formats should be performed. It would be valuable if some practitioners could share the fabrication performance using free-form models exported in IFC-4 and other formats, such as STEP or IGES. Moreover, the geometry integrity could possibly be improved if direct IFC export option is provided by software like Rhino.

Integrity of Issue Record
Due to variation in nature among coordination software, the amount and configuration of parameters in issue logging among software also differ, which creates challenges in issue exchange. In this project, coordination issues can be generated from different software, given the prerequisite that the issue logs must be exportable to BCFzip format. Despite the variety in software, BCF is able to retain essential issue information such as viewpoint orientation, etc.

However, certain fields in native issue records become dis-organized after the export. To resolve this problem, project-specific BCF-standardization could be further developed, and issues could be represented in neutralized formats such as BCFxml and BCFAPI. Mapping tools could also be developed to enhance the mapping of issue information across software.

OpenBIM Integration with GIS
From planning to design and construction stage, we realize that geographical information in site surroundings is important for different analysis. Conventionally, it is gathered from different sources, and then re-input in BIM models. However, such process is abortive and can never catch the pace of design changes. Moreover, scattered geographical information from different sources are prone to information contradiction.

With the massive amount of open data managed by openGIS and its direct analysis capability, we could attend to design changes swiftly and efficiently. OpenGIS is an efficient solution as a preliminary analysis for client to validate their design intent.

To unleash the unlimited potential of openBIM and openGIS integration, it would be beneficial to equip BIM practitioners with related skills, such as mapping point cloud for BIM and GIS, and publishing related standards and guidelines.

"We were able to identify where we need openBIM to develop further."

Operation
Smart building is marked as the ultimate vision in this project. Hence, the interfacing between BIM and Facility Management (FM) tool will be a key to sustainable operation. Realizing the interoperable and sustainable feature of openBIM, the project team foresees that IFC and COBie concept should be adopted for spatial and operation data transfer respectively. A more comprehensive openBIM standard and data exchange strategy on interfacing between BIM and FM tools will be established from a steering team consisting of different project stakeholders.

OpenBIM Awareness and Capacity
To achieve interoperability, traceability, reliability and sustainability, we are determined to establish an openBIM project context. The success of openBIM depends not only on the management, standardization and software tools, but more importantly depends on the openBIM mindset and capability of each project participants. Therefore, 90% of Main Contractor BIM staff has attained “BuildingSMART Professional (Foundation) Certificate”. Moreover, training on openBIM compatible tools (e.g. Trimble Connect and Solibri) have been extensively offered to site engineers and staff, which enables them to leverage the advantages of openBIM for practical day-to-day tasks. Given the positive feedback and raise in productivity, we believe that development of openBIM awareness and capability of practitioners would be beneficial to the project and the industry. In view of such vision, the project team actively shares their openBIM experience with the industry, such as the hybrid seminar “Opendata towards a Smart City” organized by HKABAEIMA in September 2021. Ultimately, the diffusion of openBIM will be the way for BIM development.

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Use Cases

BIM Uses were defined on the project	✓
BIM Uses formed an integral part to how the project was delivered	✓
I agree to be contacted for more information about the project BIM uses outside of this awards program.	✓

Documentation on use case(s) as a single file upload

PDF	The Henderson_08_Use Case... (19.1 MiB download)

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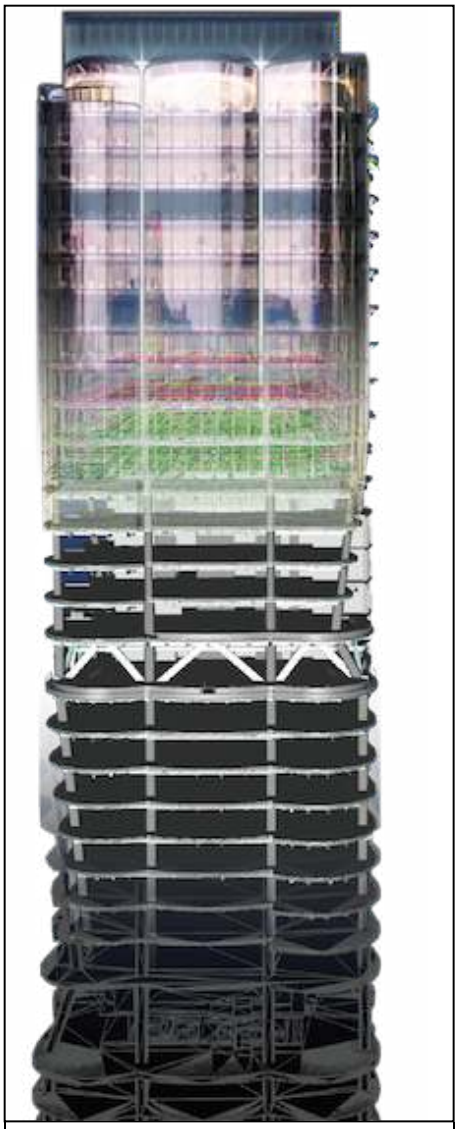

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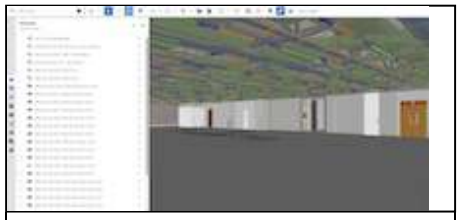

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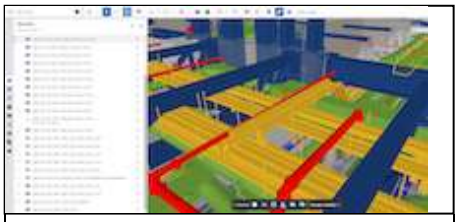

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