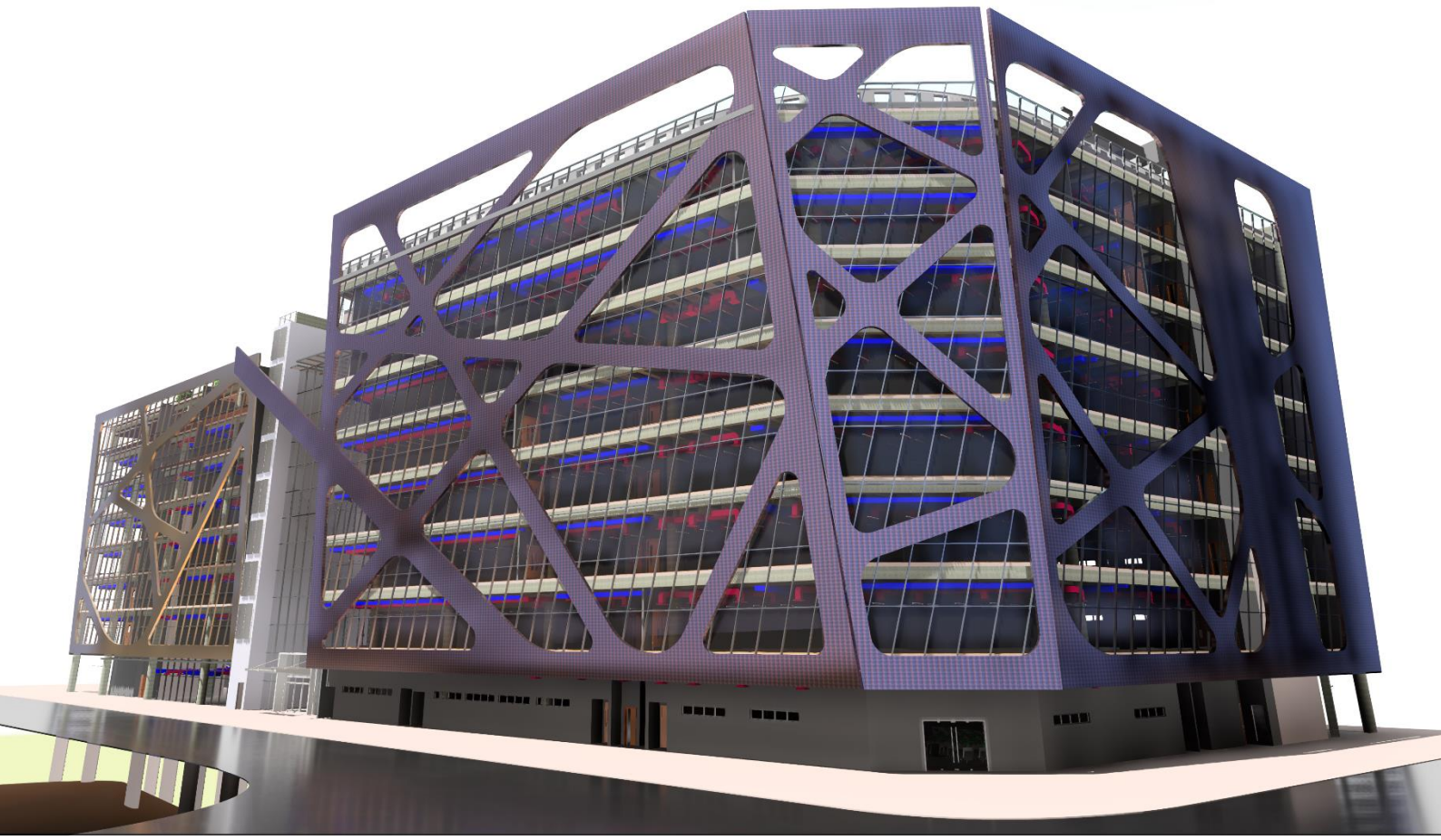
CIC BIM Competition 2019 (Open Group)

Report by *ACID*



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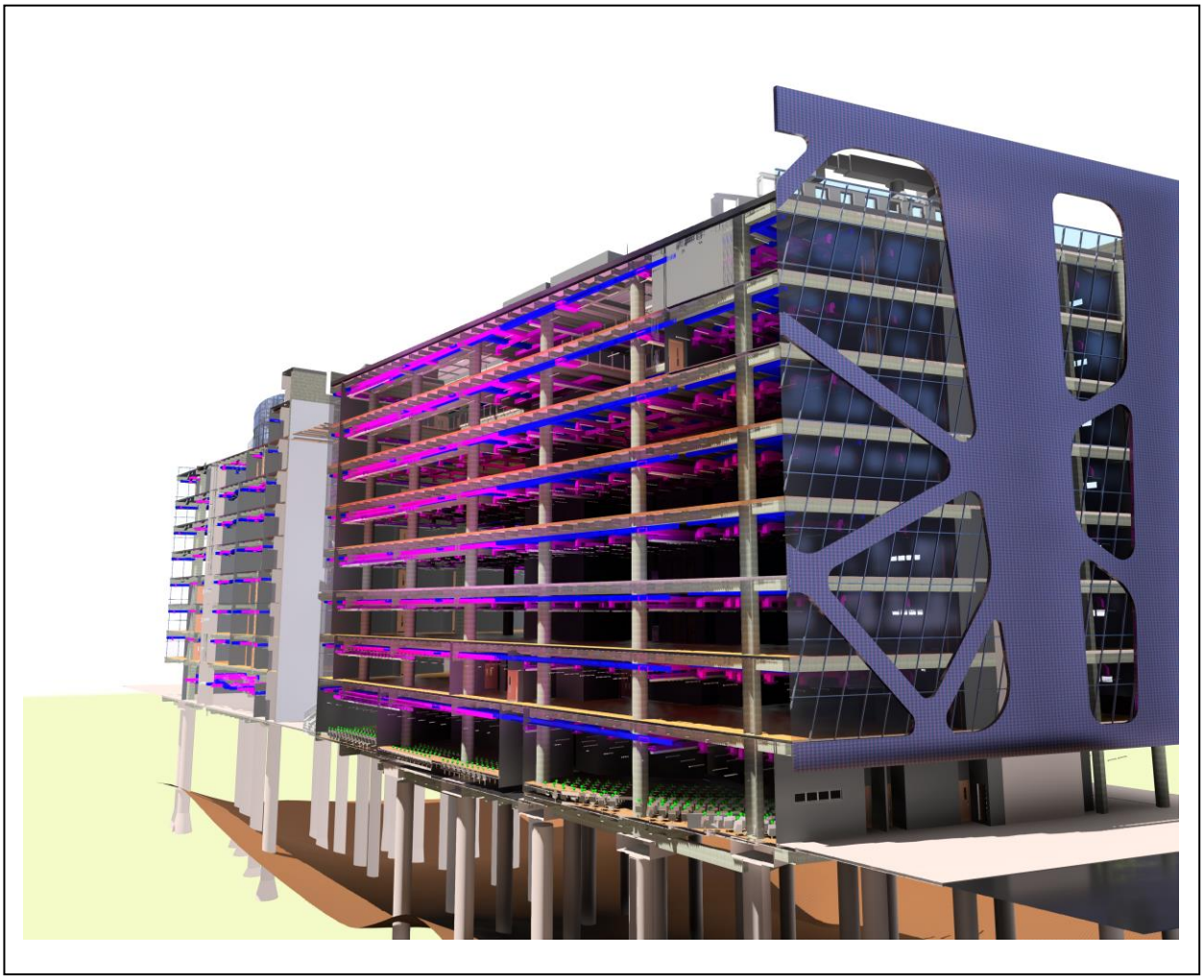

The design for Digital Design & Construction Centre (DDCC) is not only about the excellent outcome, but also showcase the overall workflow and approach of the very feasible fully adoption of Building Information Modelling (BIM) process from the very beginning of the project life cycle.

1.1 Objectives of participation

- To illustrate the practical usage of BIM through collaborative and competitive learning approach in the construction industry;
- To illustrate the idea of "Single Source of Truth" (SSOT), which is the core concept of Building Information Modelling;
- To share the knowledge and experiences in BIM application and collaboration, further demonstrate how this is effective and beneficial to the productivity and clarity of the construction industry;
- To illustrate BIM is the perfect tool on "Design for buildability"

1.2 Roles and responsibilities of team members

We have sub-divided our team and defined clearly each member play one or more particular roles, so as to simulate at best an actual design team structure and the design process that fully adopted BIM:

BIM Architect – Mr. Ping Li plays the role as the Chief Architect of this competition project, who take lead on the Architectural Design of the proposed scheme.

BIM Engineer (MEP) – Ms. Annie Cheng plays the role as the Chief MEP Engineer of this competition project who take lead on the MEP Design of the proposed scheme

BIM Engineer (Structural)- as our team does not have member with formal Structural Engineer background by discipline, all the team members share the responsibility to come up with the preliminary structural design for the scheme based on our previous working knowledge and experiences.

BIM Manager – Mr. Jason Wong plays the role as the BIM Manager of this competition project, who is responsible for facilitating and managing the BIM design and collaboration process between parties.

1.3 Overview of the complete package of submission

The capacity of BIM does not only focus on 3D modelling and visualisation, but also the ability to produce proper industry common form of documentation, e.g. 2D drawings, schedules from a single platform. The team has fully utilised the capacity of BIM which basically the whole package of submission has been directly produced and output from the BIM software, which includes:

- 2D Drawings – Plans, Sections, Elevations
- Schedules – Room Schedules, Door & Window Schedules (for quantity estimation)
- 3D visualisation – Perspectives views – overall building and illustrations of special areas
- Overall axonometric view
- "Anatomy" diagrams – Axonometric plans and sectional axonometric views for each discipline and federated model
- Exposed isometric for illustration of building composition
- Illustration of working process – Clash Management process, Statutory compliance Auditing, MEP headroom checking
- Generative design scripting
- Solar Analysis
- Animation – Dynamo Scripting for Design, solar analysis, walkthrough for design and co-ordination, clash management, Common Data Environment Co-ordination

2. Use of Information

2.1 Demonstration on understanding of the objective of competition

The core objective of the competition is to promote the practical usages of BIM through collaborative and competitive learning approach in construction industry.

Like any other innovative idea and technology, the most pragmatic way to promote and for the market willing to embrace the change is to proactively proof to the stakeholders that the BIM way for design excellence is mature and very effective for saving time and cost.

We believe that BIM is not rocket-science and should be easily approachable. Our living world is composed by objects with information, not by lines drawn on papers – BIM is instead a more straightforward way for understanding building and construction.

A design fully carried out by BIM process is therefore should be very easily understood. We hope this is well-demonstrated with our competition entry.

2.2 Identification of Key Issues

Innovative idea of teaching and training spaces

As anticipated of the upcoming era of Hong Kong Construction 2.0, the way of knowledge transferred may no longer be the same as the traditional way, so as the space designated for such purpose. How and what construction technologies might be applied would as well shape the way on how the teaching spaces – classrooms, workshops, lecture theatres and even the common area of the building may look like.

Buildability

In Hong Kong, Government is promoting the adoption of the guiding principle of "design for buildability", which is focused on cost effectiveness without undermining quality and safety. In other words, the design decisions shall make early consideration on the actual project delivery, i.e. how the construction would eventually get built.

We believe that adoption of BIM is very much the direct answer for such principle – where the BIM workflow is basically about considering a construction project as an assembly of objects, and 'rehearsal' of the actual building project in digital environment.

Streamlining BIM workflow

Each discipline carries out their design simultaneously very often in different office or different time. All parties shall understand the way to carry out the duty of their disciplines and collaboration together is critical for successful BIM implementation

Also, not dissimilar to reality, the design team has been facing a tight schedule for delivering a holistic and coordinated design, therefore a streamline and efficient approach for the process is also important.

Sustainability

For a broader picture of the whole project life cycle, planning for sustainability are both key issues during construction and operation phase.

2.3 Appreciation of the project constraints, requirements and challenges

Without difference to other project in Hong Kong or worldwide, a construction project faces several project constraints, particular requirements and challenges.

Development Parameters

First and foremost, set of site constraints are bounded statutorily – zoning and classification of site which leads to development potential parameters such as site coverage allowance, plot ratio and hence permitted gross floor area (GFA), etc. For the nature of this project and building type, maximizing the development potential is not on paramount concern, which give us certain degree of flexibility on design innovation.

However, it is noticed that to fulfil the schedule of accommodation as required by the brief and the height limit, it still poses a bit of challenges.

Context and neighbourhood

Traffic noise has quite a significant impact on the spatial planning. Most noise come from the adjacent MTRC track and station at the east of the site.

There seems to be lack of street activities (shops, restaurants, café, space just for hanging out) at the immediate surrounding of the site. As an institution open to the general public, the ground level and entrance shall be generously design to draw the attention and attract the public to enjoy the space.

At a wider site context, the building situated in a vibrant and evolving area, where both residential, commercial, institutional and industrial activities crisscross. The DDCC shall be iconic and recognisable and yet not to the extent of overwhelming.

Spatial arrangement nature of function

Various group of users are expected to come to the DDCC for different purposes – people who come for a regular basis for classes, someone who come occasionally for seminars or exhibition, or even the general public who are interested in the construction industry. Certain function spaces like classrooms or workshops shall be distinct and directional – straight to where the users need to be. Some other spaces, however, shall act as a mingle point where different people cross paths and provide the opportunity for interaction, like the exhibition area, or a decent café.

2.4 Design Concept and Background Research

Spatial Planning

The DDCC offer a warm and welcoming environment with a memorable entrance multi-storey atrium alongside the reception lobby, as well as the exhibition area and café. This serves as the focus to drawing all kind of visitors together where they mingle, cross paths and interact, before they carry on further their journey to more specific function. This concept for spatial arrangement ties into our vision of the new era of construction industry – cross-discipline collaboration with individual parties specialising and advancing in their particular fields to maximize efficiency and cost-effectiveness.

Division of block

The DDCC building is being cut into two distinct blocks at each side of the entrance atrium that responds to the needs of various user group. Left side (L Block) shall accommodate classrooms, offices and library, which are more regular identifiable users to the building such as Students and DDCC's staff. On the other hand, the Right side (R Block) shall accommodate more semi-public spaces such as workshops, lecture theatres and multi-purpose halls which shall serve general visitors and researchers.

Another practical reason for such arrangement is that the large spaces at the R Block requires higher headroom than classrooms and offices. Placing them into two separate blocks allow differentiating the floor-to-floor height while connecting them at certain levels through cross-bridges along the atrium. Such arrangement not only enhance the spatial quality, but also maximize the efficiency of the building.

Aesthetic consideration

The immediate neighbourhood of the building are rather functional and being lack of appealing factor to drive people to visit. A gesture to make the building iconic to certain extent is essential for drawing attention and make the statement. Yet, we shall also strike the balance the design with cost effectiveness and functionality, not for the sake of pure aesthetic consideration with unreasonable cost, otherwise it is against the guiding principle of the Institution.

2.5 Overall approach of the production and delivery of the project

Setup of database and documentation

BIM model can be identified as a form of database. Even before the design begins, there are information, i.e. the constraints of the project, and the file and folder structure to be setup and managed for effective implementation and BIM application to reach the goals. BIM focus on the aspect of information management, so the file, folder system and input of parameters like the SOA table into the model as the first step.

Massing and generative design

Utilizing the native function, as well as additional scripting, we approach the design by massing that inform whether or not the design fit the constraints, e.g. Site Coverage, Building Height Limit and GFA requirements.

Analysis tools application

Solar analysis as an example has been applied to various design options generated, to access and inform the performance of the building at early stage, so that allow the designers to make early decision to optimize the design.

From massing to object-based BIM model

the chosen massing serves as the base scheme to further develop the design to **Object-based** BIM model, which is in the same platform

Models of individual discipline and cross-discipline collaboration

Each discipline then begins their design process. While they share a common platform and Common Data Environment (CDE), other engineers may kick-off their design involvement not long after Architect come up with a base scheme.

Documentation and production

This may be the last step but basically this goes in parallel when the design is being developed with more details.

3. Computational Design, Engineering, Analysis and Optimisation

3.1 Architectural Design Strategy, elements illustration; how is it developed with using BIM

No Matter what tools to be utilized, certain site parameter and development potential (Site Coverage, Building Height, Permitted Gross Floor Area, etc) set out from the brief/project requirements are fundamental

Massing study and Generative design Automated base schemes with scripting

At the very beginning, we use Conceptual Massing for design. Massing is not only seen as tool for visualizing the aesthetic of form, but also Massing with information (Floor areas, Building Height) allow the Architect to come up quickly with the building bulk design that are of appropriate scale. Even when we test out the building forms in great variety and imagination, one can still always ensure the design are within range.

To help exploring more design options and opportunities, we make use of Dynamo scripting that set certain rules to the generation of the massing form with basic elements like floors, exterior wall, structural preliminary design being automatically placed.

This avoids the common scenario that the Architect in the beginning come up with some grand ideas and forms, clients impressed but only find out later it did not satisfy the development requirements when the design proceeds, and the outcome is way far from the original ideas.

Working with area and numbers (Rooms and schedules)

The table of Schedule of Accommodation of the brief was first input into the BIM model as Room Schedule, together with a field denoting the area required, even before we start the design process. The rooms are then placed into the model, and with certain settings of the schedule we shall know and highlight whether the provided areas are within range compared with the required areas.

Statutory Compliance Audit

With view and filter setting rules, we demonstrate certain statutory compliance can be checked almost instantly when the scheme is formed. These may 1) include highlighting the location of fire routes or 2) checking of construction FRR or wall thickness and material, so that we see whether certain fire protected routes are properly enclosed or not.

3.2 Structural Engineering elements and analysis illustration; how is it developed with using BIM

Visualising the structural layout in 3-dimension help identify issue, particularly for special areas, dealing with level differences. Area with greater structural complexity are isolated out for visualization and analysis, such as the skylight of the building. Exposed isometric views are also setup to identify different structural components.

Anatomy of the structural frame

Axonometric Structural framing plans and sectional axonometric views are setup for the structural model for easy understanding for the whole building. This enhance clarity of the engineering design intent which is easily understandable for junior staff, team member from other disciplines, clients or even layman.

3.3 MEP Engineering elements and analysis illustration; how is it developed with using BIM

Anatomy of the MEP system

Same approach as structural, MEP system is way more complex and may sometimes be difficult for even junior engineers in MEP discipline or other profession of other discipline to understand. Combined Services axonometric plan and sectional axonometric views are setup for the MEP model for easy understanding for the whole building.

Generate Layout

Conventionally, MEP engineer begins their input by designing schematic diagrams, with 2D and single-line. BIM as an object-based platform, allow generating layout with BIM objects in 3D environment, that simulate the actual physical built world.

Solar Analysis

The team carries out solar analysis to assess the energy and insolation performance of different design options. The scheme with optimized result was chosen for further development. It also indicated area of concern, i.e., which area of the building receive less average daylight for the designer to look for solution.

"Heat" map – headroom analysis

Whether the MEP system design provide sufficient headroom for the space beneath are very important set of information the designers have to know, but unable to be easily obtained. with the help of the BIM model and additional plug-ins tool, we can generate an analytical view to illustrate the clear headroom, like a heat map, and identify issue.

3.4 Illustration on use of BIM Platform; methodology of multidisciplinary design coordination and team collaboration

Same native BIM platform

The team adopt the approach for all discipline to be working at the same BIM software, to allow file exchange and cross-reference in the most effective manner.

Common Data Environment

Different discipline work at different office locations but frequently exchanging and cross-linked with each other is critical for effective design collaboration. The team has make use of cloud-based Common Data Environment to place the authoring models at the same platform, such as Revit Server and BIM360.

Federated model review

Revit is a BIM authoring tool but not always the most effective tools to visualize and navigate through the combined model. To serve this purpose, once the individual discipline models reach a certain level of maturity, they are put together as a federated model under Fuzor / Navisworks for design review.

Clash management

Conventional clash detection report does not really help improve design quality. The team has applied further technology being developed to manage clash in a much more effective way. The clashes are prioritized by ranking system so that only major clashes are indicated, and those clashes are visually clearly identified – not only at the federated model but also feedback into the BIM authoring model, which is where designers make changes in order to resolve design clashes.

4. Creativity, Innovation & Technology

4.1 Design creativity, innovation & technologies applied in relation to architectural, aesthetical and environmental aspects

Oval shape classroom

The mode of teaching and learning may not always be the same as current and traditional, so does the spatial design and arrangement of the classroom. A few classrooms in the proposed DDCC has been designed in oval shape, which might facilitate interactive approach of teaching and learning or advance technologies developed in the future.

Sky garden and vertical greening

While there are relatively limited room for green features at ground level, sky garden and vertical greening has been implemented to improve sustainability performance of the building.

4.2 Engineering creativity innovation & technologies applied in relation for sustainability

Natural lighting

Locations of skylight and atrium has been strategically planned according to the analysis result, at area that need more natural lighting. The external façade skin, on the other hand, provide certain extent of shading to area that may receive more direct sunlight.

MEP engineer efficiency

System requirements for rooms with different functions and spatial arrangement may varies. While rooms with similar functions are group together in certain zones allow more efficient planning of MEP system. This approach shall allow a clean and neat MEP system design, which are often undermined for its impact on design quality and maintenance/operational cost effectiveness. It also saves construction cost for redundant plant rooms and routings.

4.3 Construction creativity, innovation & technologies

Lifting platform machine

It is reckoned that for workshop and class, as well as exhibition of construction technology, building materials and large pieces may often be delivered to the building. Conventional approach tends to spend extra resources and materials to 'hide' this back-of-house activities. However, with the nature of the DDCC where construction or logistic of material delivery are themselves part of the construction, we propose to expose the process for efficiency. We've designed an exposed lifting platform machine along the vehicular access of the building. Right at the materials or equipment being dropped off, they can be instantly delivered to the appropriate floors

During construction, this will be served as the vertical transportation as well.

Maximize level of modularization and pre-fabrication

Even though the design is not conceived as conventional and regular form, there are certain level of modularization. E.g. classrooms across a few floors shall share the same layout. With the help of BIM, they can be designed as modular and pre-fabrication might be done off site in advance.

5. Closing

Learning Outcomes

Building Information modelling is undoubtedly a powerful tool for improving productivity in construction industry. Yet, not dissimilar to any other kind of technologies and knowledge, there are nothing perfect and "one-size-fit-all" solution. There are always room for improvement on how things being done.

On the other hand, no matter how such technology offers any brilliant solutions to problems, it is nothing until it is put into action.

This competition entry tried to demonstrate a holistic approach and suggest how a typical BIM workflow put into practical usage. It would not be perfect solution, but hopefully this entry could proof the general usage of BIM could improve the design and construction quality to certain extent.

One thing to have learnt and put to note is that, BIM is a process that facilitate the design and construction process, not the design process itself. A proficient BIMer does not necessarily mean one is a good designer. From the process, it is believed that the best way for BIM implementation is to enable designers with the BIM knowledge and mindset

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