BIM: CHALLENGE FOR TEAM WORKING BASED ON HUMAN'S NATURES PROTOTYPES

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1. ABSTRACT

Building Information Modeling (BIM) is a process aiming at building a rich information model which, aside from graphical data, also includes non-graphical information such as performance requirements and associated documentation. Following human nature's complex function, BIM consists of an efficient structural approach composed of different types of models and systems (architectural, structural etc.) integrated through plug-ins, allowing information co-ordination in order to design stable, durable, elegant and economic structures in specified conditions.

BIM practice is not just about using compatible software, but a more collaborative method of working. Facing BIM challenges an interactive working Design Team, called D4S-TDS, consists of a creative multi-faceted structural design led practise that specialises in the creation, extension and alterations to the built environment whilst enhancing engineering excellence.

2. INTRODUCTION

Building information modeling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places. Building information models (BIMs) are files which can be extracted, exchanged or networked to support decision-making regarding a building or other built asset. Current

BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain diverse physical infrastructures, such as water, refuse, electricity, gas, communication utilities, roads, bridges, ports, tunnels, etc.

BIM isn't new. It first appeared as early as 1962, when Douglas Engelbart wrote his paper "Augmenting Human Intellect: A Conceptual Framework" [1] and described architect entering specifications and data into a building design and watching a structure take shape—a concept very similar to modern parametric modeling. The term "BIM" was first used back in the '90s, but the recession put a damper on its early stages. It picked back up after the recession and has really taken off in recent years. Because it was a bit of a late bloomer, BIM might seem like a brand-new and scary thing for dedicated CAD users—but the shift from CAD to BIM has been a long time coming.

Traditional building design was largely reliant upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D). BIM therefore covers more than just geometry. It also covers spatial relationships, light analysis, geographic information, and quantities and properties of building components (for example, manufacturers' details).

Structural design can take advantage of BIM in different ways, as the model can be constantly updated with any changes in the design or general specifications, keeping all the data as accurate as possible. BIM transforms the way we handle and visualize components. [2] It has grave impact on designing activities like, conceptual design and structural analysis. BIM ensures reduction in design and drafting errors and hence provides with lower designing cost and improved productivity. It also allows for better analysis of situations through simulation. The fact that the use of BIM lets one visualize the whole picture lets one identify potential design issues, and come up with new and creative ways to solve problems.[3]

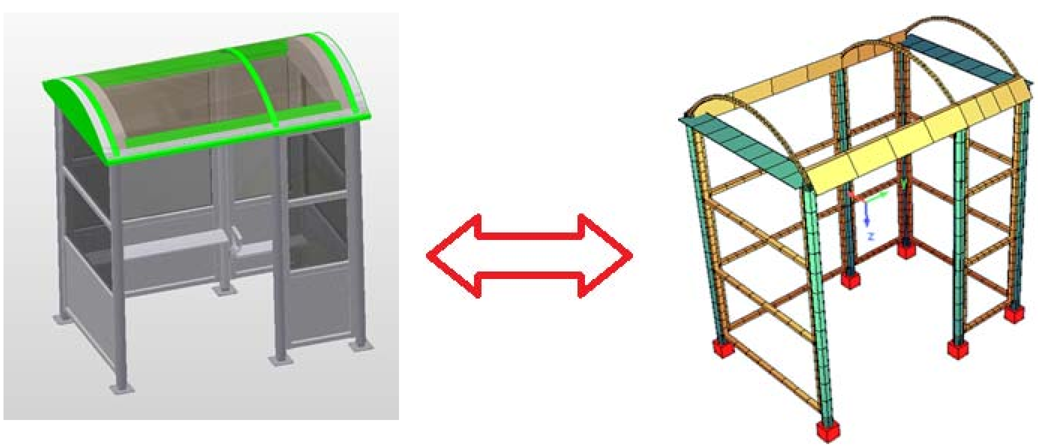

Fig. 1: BIM model: exchanging information between architectural & structural design

With BIM, referencing the architectural plans is still the first step. But instead of creating several models, there is just one model, a single integrated structural model that includes both a physical representation that drives documentation and coordination and an analytical representation used for multiples analyse (Fig.1).

While using a building information model, both the physical, which contains the data used in the analysis applications, and analytical information, which is the model used in the structural analysis, are interconnected in the same place, allowing for its use not only in the structural analyses of the project, but also to produce the construction documents. The structural members like beams, columns, that are part of the physical representation can be assigned load, material properties and other important information necessary to run the structural analysis. It also contains the geometric properties, strength of the materials, and boundary conditions of the structural members. Structural analyses programs can then import all this information thanks to embedded tools and application programming interface (API). After the analysis process is finished, the model can be exported with the results, automatically updating all the information, and the documentation dependent from it. This results in an intelligent 3-D model of the structure in which elements of the design are related to each other dynamically.

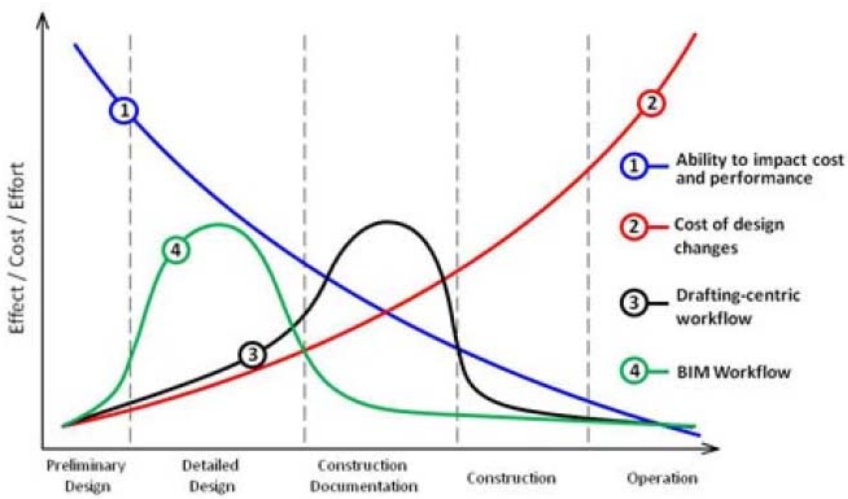

Fig. 2: Level of effort required in BIM

Time constrains usually dictate that structural design and construction documents production start parallel, so as the structural engineers begin their analyses, the structural drafters begin developing the documentation set (framing plans, bracing elevations, typical details).As the green line in Figure 2 [2] demonstrates, by dynamically connecting design, analysis, and documentation in a BIM workflow, most of the effort in a structural design project is shifted back into the detailed design phase when the ability to impact project performance is high and the cost of making design changes is low. This allows engineers to spend more time evaluating what-if scenarios to optimize the design and less time generating construction documentation. The difference between BIM approach and traditional drafting-centric approaches, design, analysis, and documentation is that the second ones are disconnected processes, making evaluation of what-if scenarios inefficient and cost prohibitive. BIM based structural design tools help engineers optimize their structural design, to compare and contrast various approaches to sustainable designs with associated lifecycle costing, and when a concept is approved, it provides the foundation for construction sequencing and field operations.

3. BODY INFORMATION MODELLING – STRUCTURE

The human body is the entire structure of a human being. It is composed of many different types of systems and mechanisms, interacting in order to maintain well-being and viability. Building Information Modeling (BIM) is a process aiming at building a rich information model which, aside from graphical data, also includes non-graphical information such as performance requirements and associated documentation. Following human nature's complex function, BIM consists of an efficient structural approach composed of different types of models and systems (architectural, structural etc.) integrated through plug-ins, allowing information co-ordination in order to design stable, durable, elegant and economic structures in specified conditions.

An interesting case study, that Jonathan Lock led the structural design whilst working with Arup, could match as part of the above appetite to make the construction industry more efficient, and reduce environmental impact through digital technology and a more standardized process. Project OVE is a concept design for a tall building based around a real human form. As well as the structural design, the referred work focused on improving relevant Processes, Workflows, Interoperability and Deliverables. The process began by using laser scan data to inform the creation of an architectural model that follows the incredibly complex geometry of the human form. The highly complex steel structural geometry model, after been up-dated through a number of different structural software packages, was turned into fabricatable structural elements in Tekla.

4. HONG KONG AIRPORT – TERMINAL 2 EXPANSION

D4S-TDS team has a huge amount of experience in consultancy and implementation of BIM on many different types of projects. Recently, they have been commissioned by AECOM to assist them in their prestigious project for Hong Kong International Airport. As part of the airport's expansion, the existing Terminal 2 (Fig. 3) will receive a new roof and façade and this is where the specialist Steelwork Connections Team has come in. The D4S team has been responsible for the structural design of the connections that make up those new additions.

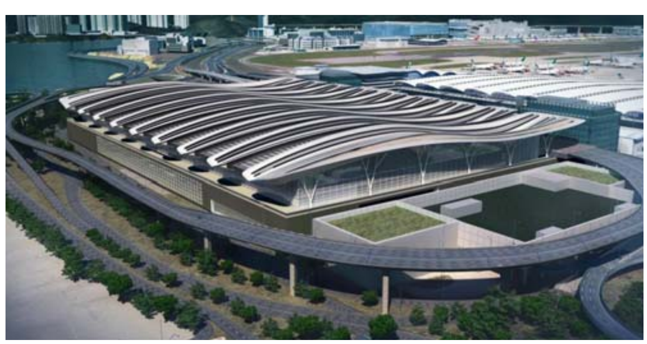

Fig. 3: Terminal 2 – Expansion Structure

The roof for Terminal 2 is a movement joint free steelwork structure, covering almost 70,000m^2, with a curved profile front to back and saw tooth profile in cross section. The roof is formed of 7 bays of structure defined by column trees that support the primary (cloud) trusses and in turn the secondary (feather) trusses. The roof is founded on the reinforced concrete superstructure of the building below, and is a portal frame in each direction.It has been a striking design, requiring our expert capability in providing, among other services; primary and secondary roof truss designs, almost 50 different connection types, structural calculations and IFC connection detailed models to identify fabrication and erection issues.

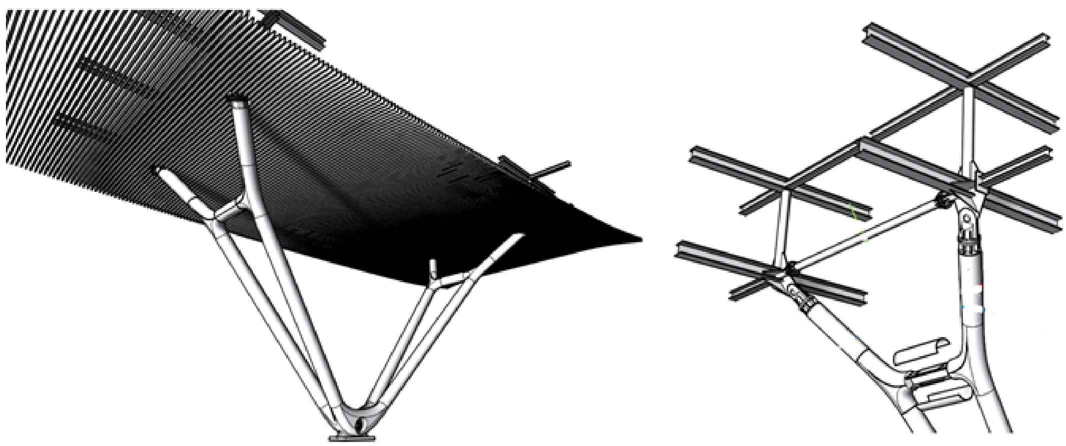

Fig. 4: Tree Connections – BIM Model

BIM has been chosen as a scalable solution, in order to transmit with great accuracy all the required information between the different types of the design. Revit & Rhino models have been provided in ifc export format (Fig. 4) to D4S for reference to geometry and setting out. They were used as a basis for the connection geometry and the detailed design, conducted by the expert connection D4S design team in accordance with the Hong Kong Code of Practice for the Structural Use of Steel 2011. All the required verified connection data, concerning geometry, special fabrication (e.g. access for shop welding) and erection techniques have been transmitted from the Design Team to the TDS, a skilled & experienced digital designers team. They have been utilising Tekla Structures to produce data rich 3D models which formed part of the wider BIM process. Detailed, as-built building information models would enable the highest level of constructability and production control. Centralising model and non-model based data into the 3D model could allow for more collaborative and integrated project management and delivery from conceptual design to construction. The referred produced ifc models were provided back to AECOM for import into the architectural software Revit and suitable for documentation.

Centralising building information into the model allows for more collaborative and integrated project management and delivery. This translates into increased productivity and elimination of waste, thus making construction and buildings more sustainable. BIM has and will change the way the construction industry works, impacting on the operations and processes of any organisation utilising the benefits of BIM.

5. CONCLUSIONS

BIM is not restricted to designers and contractors, but is relevant to everyone involved in the built environment. Clients, agents, subcontractors, architects and manufacturers all need to have strategies and plans, and increasingly the facilities management community has a pivotal role to play.

Using the building information model not only enables the production of construction documents, but it also serves as a base to present the results from the structural analysis and design in an easy sharable way, keeping all the information regarding the analysis, design and documentation of a structural project in one place. A single building information model is used for both the analysis and the documentation phases, contributing to better coordination between the structural analysis results and the overall design, increasing consistency throughout the entire project.

The improved coordination can also be seen in better interoperability between team members' software's, allowing architects, structural and MEP engineers to manage a project more effectively. The ability to create simulations and check different structural scenarios greatly help with analysing a structure and taking decisions. This provides great project insight, enhancing its understanding and facilitating the process of solving problems and coming up with ideas. These visualizations can be used to present ideas in a more clear way, simplifying the process of explaining complex situations and helping teams communicate more adequately.

6. REFERENCES

[1] ENGELBART DOUGLAS, "Augmenting Human Intellect: a conceptual framework", SRI Summary Report AFOSR-3223, October 1962.

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[3] HUNT CESAR AUGUSTO, "The Benefits of Using Building Information Modeling in Structural Engineering", Utah State University DigitalCommons@USU, Graduate Study 8-1- 2013.

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ΠΕΡΙΛΗΨΗ

Η τεχνολογία BIM είναι μια διαδικασία που αποσκοπεί στη δημιουργία ενός ψηφιακού μοντέλου πληροφοριών, το οποίο εκτός από τα γραφικά δεδομένα, επίσης περιλαμβάνει μη γραφικές πληροφορίες, όπως απαιτήσεις εκτέλεσης και τεκμηρίωσης. Ακολουθώντας την πολύπλοκη λειτουργία της ανθρώπινης φύσης, το BIM αποτελεί μια αποτελεσματική κατασκευαστική προσέγγιση συντιθέμενη από διαφορετικά μοντέλα και συστήματα (αρχιτεκτονικό, στατικό, κατασκευαστικό κτλ) ενσωματωμένα σε συνεργαζόμενα λογισμικά, επιτρέποντας τη διαχείριση των πληροφοριών, με απώτερο στόχο το σχεδιασμό εύρωστων, ανθεκτικών, κομψών και οικονομικών κατασκευών σε δεδομένες συνθήκες.

Η πρακτική του BIM δεν συνίσταται απλά στη χρήση συμβατού λογισμικού, αλλά αποτελεί μια συλλογική μέθοδο εργασίας. Αντιμετωπίζοντας τις προκλήσεις του BIM, μια διαδραστική ομάδα Σχεδιασμού, αποκαλούμενη D4S-TDS, αποτελεί μια δημιουργική πολύπλευρη κατασκευαστική πρακτική σχεδιασμού που εξειδικεύεται στη δημιουργία, επέκταση και βελτιστοποίηση του κατασκευαστικού περιβάλλοντος, ενώ ταυτόχρονα εμπλουτίζει και ενισχύει την επιστήμη του μηχανικού.