IMPLEMENTING BIM & PAPERLESS DESIGN: BAKU OLYMPIC STADIUM – A CASE STUDY

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1 SUMMARY

The present paper is focused on the implementation of Building Information Modeling Technology for the design and construction of the Baku Olympic Stadium in Azerbaijan. Following a brief introduction to the basic rules of this new term BIM, the paper presents in detail the actual strategy that it was used between the participants for sharing and developing the vast quantity of data within a very tight time schedule and significant geographical diversity.

2 INTRODUCTION

According to the National Building Information Model Standard Project Committee, Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle. Models created using BIM represent more than geometrical data. They are used to include information about aspects of the projects such as construction materials, their properties and origin, schedule constraints, costs, or even the life cycle management information of a project. One of the most important responsibilities of engineers and contractors is their efficient collaboration when creating a project. Exchanging information between architects, engineers and construction disciplines is not new. Blueprints have been used throughout the years. Rough sketches were also added to the collection of shared information. Finally, 3d computer generated imaging (CGI). Artistic renderings were a common example of visualized information. Since the need for collaboration and information management is perpetual and technology and construction procedures get more and more complicated, there is also a need for the change of the mechanism of the exchange of information.

The workflow implied by BIM is completely different by the corresponding CAD (Computer Aided Design) process. The use of several files for every part of the project and their separate and non linked production is replaced by a unique file that includes all the relevant information. The use of CAD tools provide files without 'intelligent' connection between them, while a product created using BIM provides a central management of the buildings' assets. BIM eliminates any linear and single direction workflow, since relevant information is shared between collaborating parties. Important factors such as design choices, structural demands and many more aspects are changed throughout the corresponding software easily, ensuring the quality of the project through easy and constant data exchange between engineers, architects or contractors.

The Olympic stadium in Baku is a prime example of the benefits of using BIM, able to showcase the speed and design quality of a desired project at every level of its development. The Olympic Stadium of Baku (Figure 1) is currently being constructed by the Turkish general contractor TEKFEN CONSTRUCTION AND INSTALLATION co., under the funding of SOCAR, the state oil company of Azerbaijan. HEERIM ARCHITECTS & PLANNERS Co., Ltd. (Seoul) performed the architectural design and THORNTON TOMASETTI (New York) the structural. SDENG (Volos) and TEKFEN ENGINEERING (Istanbul) performed the Detailed Engineering, 3D modeling, and BIM coordination.



Fig. 1 The Olympic Stadium of Baku

3 THE TEAM. THE DECISION. THE GENESIS OF THE BIM.



Fig. 2 Locations of key participants and the geographical diversity of the team

From kick-of meeting in TEKFEN office in Istanbul it was clear to all participants that the only way to achieve maximum team - working efficiency at such a limited time would be the implementation of BIM. This decision was taken having in mind that key participants had previous experience in sharing data through different software platforms, develop, update and send back to the main BIM.

TEKFEN's site engineering team in BAKU took over the difficult task to train site personnel in the use of this technology. By using 3d viewers and 3d notes on site the contractor made a huge step to paperless workflow which proved priceless later on.

The conscious decision from beginning was to create a preliminary accurate BIM in TEKLA STRUCTURES platform and then transfer it to REVIT. The REVIT BIM model then would play the role of the main coordinating tool.

The preliminary BIM was initially created by SDENG (Volos) including the main structural elements concrete, precast, and steel. This preliminary BIM was transferred then to REVIT platform handled by the engineering team in Istanbul, and become the starting point for the genesis of the BIM.



Fig. 3 Paperless workflow using open BIM technology

4 IMPLEMENTATION

During the creation of the BIM only engineers were used instead of cad technicians. This decision has been proved very successful to the progress of the project. Due to this fact, the accuracy of the initial BIM was so significant that allowed this model to become the core for the complex final models.

The preliminary BIM contained concrete, precast, and steel members with special attributes describing estimation of time deliveries.

Although the Contractor's fabrication facility in Ceyhan (Turkey) was not operating an adequate ERP software to take benefit of these 4D preliminary data, these were transferred to REVIT and then to PRIMAVERA PPM.



Fig. 4 Preliminary BIM

The preliminary BIM was used to exchange data with analysis engineering software SAP2000 for the Roof installation verification. (Fig. 4).

Autodesk 3dsMax platform was used to perform kinetic tests, and animate the complex installation procedure (Fig. 6).



Fig. 5 Roof Installation verification SAP2000 platform



Fig. 6 Roof Installation animation 3dsMax platform

As the 3d modelling was developing the exact geometry for the complex pinned steel joints was exported to 3D FEM analysis software for verification of the plates, profiles and welding.



Fig. 7 FEM Analysis of the Steel structure Joints

5 SHARING DATA

The limitations of Internet connections proved that real time or even every day data share could not be realistic. So file sharing once a week (Friday upload) and (Monday download) via a dedicated FTP server for the first 4 months and after that twice a month was the optimum solution.

The TEKLA STRUCTURES team in Volos was updating the Total BIM with Structural Steel data. The TEKLA STRUCTURES team in Istanbul was updating the Total BIM with In situ Concrete & Precast data. The REVIT team in Istanbul was responsible for updating the Total BIM with architectural and Mechanical data.

When construction started and models were shared also with General Contractor, the teams were rescheduled to support more tasks such as, production of continuous flow of fabrication drawings, M.T.O lists, automatic scheduling via the PPM etc.



Fig. 8 Revit Model including, Architectural, Structural & Mechanical data



Fig. 9 Tekla Structures Model including steel, insitu and precast concrete data



Fig. 10 Tekla Structures Model including Architectural, Structural & Mechanical data



Fig. 11 Full fabrication structural steel drawings

6 REAL TIME USE OF MODELS DURING CONSTRUCTION

As the BIM was upgrading with more details the participants could solve complex issues in models that would result significant detail and confusion to production chain if they were solved on site.



Fig. 12 Complex solution given in BIM than on Site



Fig. 13 Kinetic check of the 210 tons dual truss lifting was animated prior to installation



Fig.14 View of Total BIM model including all data & roof installation procedure

7 FEEDBACK, 4D & 5D MODELING

From the preliminary BIM the key parts of the project included the attributes describing the estimated time deliveries. These attributes were transferred to the Total BIM and then

to PPM platform (Project Portfolio Management). This allowed to create a realistic animation of the construction sequence and to define the project milestones.



Fig.15 View from the realistic construction sequence using time attributes from BIM

8 LESSONS LEARNED & THE GLOBAL BIM AWARDS

Using BIM to a project of the size and complexity of the Baku Olympic Stadium requires a new step of trust and reliability between the participants. Traditional time schedules and emails are substituted from models that show a clear view of all participants' progress of work. This new true relationship requires careful planning and willing from all participants to accommodate each other's needs. Upfront investment in training and time will show the beneficial results later.

The BIM of Baku Olympic Stadium by SDENG & TEKFEN ENGINEERING was awarded with the public vote in the Global BIM Awards of 2013 for the category Total BIM. The ceremony was held in Berlin in February of 2014 during the Tekla European Forum 2014 were Sophia Sarri on behalf of the 2 companies received the award.



Fig. 16 Sophia Sarri receiving the Global BIM award.

9 ACKNOWLEDGEMENTS

Project.

Client. General Contractor. Architect. Structural Design Mechanical Design Detail design & BIM Baku Olympic Stadium Capacity: 68,000 spectators Total site area: 496,000.00 sqm, Building area: 86,853.30sqm SOCAR (THE STATE OIL COMPANY OF THE AZERBAIJAN REPUBLIC) TEKFEN CONSTRUCTION AND INSTALLATION co. HEERIM ARCHITECTS & PLANNERS Co., Ltd. THORNTON TOMASETTI WOOWON M&E inc. TEKFEN ENGINEERING - SDENG

ΕΦΑΡΜΟΖΟΝΤΑΣ ΒΙΜ & PAPERLESS DESIGN: ΤΟ ΟΛΥΜΠΙΑΚΟ ΣΤΑΔΙΟ ΤΟΥ ΜΠΑΚΟΥ

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ΠΕΡΙΛΗΨΗ

Η εξέλιξη της υπολογιστικής ισχύς των ηλεκτρονικών υπολογιστών έχει οδηγήσει τα τελευταία χρόνια στην μετεξέλιξη διαφόρων πακέτων λογισμικού σε ολοκληρωμένες πλατφόρμες ψηφιακής απεικόνισης. Η ψηφιακή απεικόνιση των τεχνικών έργων μέσω αυτής της τεχνολογίας επεκτείνεται πέραν της αποστειρωμένης περιγραφής των γεωμετρικών χαρακτηριστικών τους σε ιδιότητες παραγωγής, χρόνου κατασκευής, κόστους και συντήρησης. Η χρήση ενός συστήματος BIM και η απουσία της παραδοσιακής απεικόνισης των σχεδίων σε χαρτί (PAPERLESS DESIGN) αποτελεί τον πιο σύγχρονο τρόπο μελέτης, διαχείρισης και κατασκευής των τεχνικών έργων. Η κοινή πληροφορία, μπορεί να περνά από τα αρχιτεκτονικά σχέδια στη στατική μελέτη και τα προσομοιώματα, στη μηχανολογική μελέτη, στο έλεγχο κόστους, και μετά την ολοκλήρωσή τους να επιστρέφει στο συντονιστή του BIM, προκειμένου να γίνει ο τελικός έλεγχος αλληλεπίδρασης. Καθ' όλη την διάρκεια εξέλιξης του έργου το ψηφιακό αυτό μοντέλο ενημερώνεται σε πραγματικό χρόνο από τα κατασκευαστικά σχέδια των επιμέρους μελετών και τροφοδοτεί με δεδομένα ηλεκτρονικές πλατφόρμες διαχείρισης της αλληλουχίας εκτέλεσης των εργασιών (χρονοδιάγραμμα).

Η παρούσα εργασία παρουσιάζει ένα παράδειγμα χρήσης τεχνολογίας B.I.M. που εφαρμόστηκε στο έργο κατασκευής του Ολυμπιακού σταδίου του Baku, στο Αζερμπαϊτζάν. Η τεχνολογία αυτή αποτέλεσε τον βασικό κρίκο επικοινωνίας και ανταλλαγής δεδομένων για την κατασκευή έργου και δημιούργησε το υπόβαθρο ώστε η δεδομένη γεωγραφική ποικιλομορφία μεταξύ των συντελεστών να αποτελέσει το στρατηγικό πλεονέκτημα στην εξέλιξη του.