CLASH FREE BUILDING WITH MEP COORDINATION BY USING BIM PROCESS

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ABSTRACT

Building Information Modelling (BIM) has its advantages Building construction in improving Mechanical, Electrical and Plumbing (MEP) layout in such as preliminary design and model and detailed design stages. Unfortunately, BIM modelled applications normally stop prior to the construction stage, and the downstream stages have been finished become the arena of BIM applications. Therefore, the MEP layout optimal design from BIM will no longer fit properly to the installation space if there are as-built deviations in the construction of these spaces. This paper presents an approaching the BIM to optimize MEP layout from preliminary design into construction phase. In this, BIM models are developed at four level they are- 3D MEP preliminary design model, 3D MEP detailed design, 3D MEP construction design, MEP construction model and MEP prefabrication model. The results show that BIM can efficiently improve MEP layout and reduce cost, and construction preparation stage and construction stage should be paid more attention so as to insure MEP installed successfully.

Keywords: **BIM PROCESS, AUTO-CADD, REVIT STRUCTURE, REVIT MEP, REVIT ARCHITECTURE.**

I. INTRODUCTION

Nowadays, Mechanical, Electrical, and Plumbing (MEP services) systems become more complex in design coordination which requires more space available for installation. And then available clearance space in buildings is limited due to the economic and energy efficient also consideration. Therefore, the coordination of MEP systems has become a major challenge particularly in design properties such as commercial buildings, large-scale public buildings and infrastructure. Mechanical, Electrical and Plumbing coordination involves locating equipment and routing Heating, Ventilating, and Air-Conditioning duct, pipe, and electrical raceway in a manner that satisfies many different types of property. In the current Mechanical, Electrical and Plumbing coordination process, designers among Mechanical, Electrical, and Plumbing are generally lack of cooperation, so as many collisions to occur. The traditional Mechanical, Electrical and Plumbing coordination practice uses a process of overlaying and comparing drawings for multiple systems, during which representatives from each MEP trade work together to detect and functional interference among MEP systems. Such multi-discipline effort is time-consuming and expensive.

In the Building information modelling (BIM), the current MEP coordination process is now able to evolve in this technology. In the last 15 years, considerable efforts have been made to use BIM for MEP coordination. Those works can be divided into below main categories:

(1) The reasoning for MEP coordination based on BIM process.
(2) Demonstrate how BIM can improve the MEP coordination process of work.
(3) Develop some tools or methods to support MEP coordination automatically and intelligently and
(4) Investigate the state of practice of BIM in MEP coordination and suggest improvements.

Therefore amount of research efforts have been focusing on implementing BIM/3D CAD in design stage. The optimal MEP layout cannot be fully realized in its installation because of the actual as-built deviations in the space that hosts the MEP systems. For example, with BIM, designers may find more than 2000 errors in a MEP layout in the design stage, and up to 10 lacks would have been saved if every error had been solved correctly. However, due to designers limited construction knowledge and expertise, the final Mechanical, Electrical and Plumbing layout scheme may be found another 500-600 incorrect issues in the installation environment. And after entire design errors are found and solved, potential problems still exist if regardless of construction deviations which impact MEP installation. Hence, previous evaluation and coordination process about BIM based Mechanical, Electrical and Plumbing layout optimization are inappropriate. This paper presents an approach of utilizing BIM to optimize Mechanical, Electrical and Plumbing layout from preliminary design into construction phase. In this framework, BIM models are developed at some level-of-details- MEP preliminary design model, 3D MEP detailed design model, 3D MEP construction design model, MEP construction model and MEP prefabrication model. For this types of optimization methods have been developed to demonstrate and also solving constructability issues.

II. BIM PROCESS MEP LAYOUT

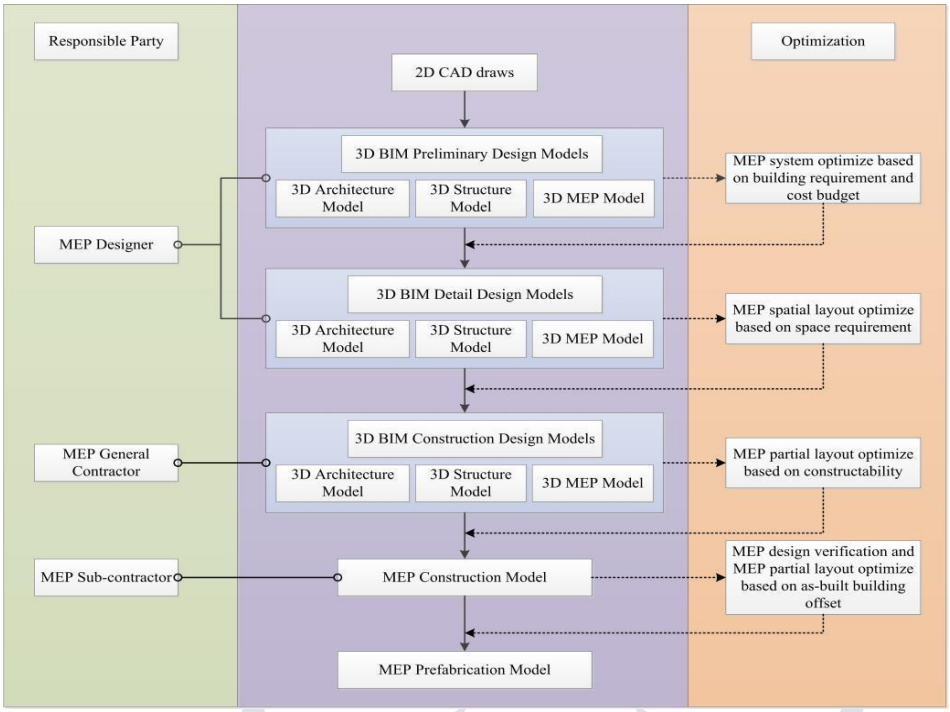

Figure1: BIM PROCESS MEP layout optimization

This section describes a BIM enabled Mechanical, Electrical and Plumbing layout optimization framework (as shown in Figure 1) which consists of 3D MEP Preliminary Design Model, 3D MEP Detailed Design, 3D MEP Construction Design, MEP Construction Model and MEP Prefabrication.

There are four steps of optimizations in the overall MEP coordination process.

Step1: MEP system is based on building requirements and budget.

In MEP preliminary design phase, more than one alternative Mechanical, Electrical and Plumbing schemes might be provided. Then, designers cannot comprehensively analysis those in order to appropriately solve problems based on 2D drawings. When using BIM, 3D MEP preliminary design model is already create. Designers can conduct sunlight analysis, Indoor Air Quality, energy analysis, ventilation simulation and so on. The best MEP scheme will be selected and optimized to a satisfied the Cost budget and Green building standards. The optimization in this stage is focused on the comparison between alternative Mechanical, Electrical and Plumbing systems. For example, lighting analysis contains,

- Design lighting while to light level and performance requirements and minimizing measures
- Base lighting design on optimize day lighting,
- Optimize outdoor and the landscape lighting.

Step2: MEP layout optimization based on space requirement

In Mechanical, Electrical and Plumbing (MEP) detailed design phase, there are many collisions when integrating with Mechanical, Electrical and Plumbing systems into one single platform. So that design overlay 2D drawings on to identified clashes manually, it is time consuming and also inefficient. Automatic clash detection can be easily realized by automated BIM tools in MEP spatial layout optimization. For the structure of large span, designers will make fire protection pipes through high beams to improve use space clear height on all sides. For vertical space area, designers also consider adding similar pipes to avoiding cross way. For Ex: In order to avoid waste pipe cross, waste pipe can be divided into two parallel, then merged into one pipe after entering into pipe to conduit shaft. These optimization method is effectively reduce the height of space in building.

Step3: MEP partial layout optimization based on construction field

Prior to construction, Mechanical, Electrical and Plumbing (MEP) contractors based on final results from the Mechanical, Electrical and Plumbing (MEP) designers, but MEP designers need to be responsible for the whole MEP design. Construction knowledge is applied to assure that feasibility of building the system and to increase the efficiency of field works. Some of Ex: of construction knowledge for the MEP layout optimization in this phase are,

- Access requirement, e.g., provide path and for construction craftsmen, materials, and construction equipment,
- configuration, e.g., use standard materials and configurations, allow desired installation in proper sequence, minimize fittings and field connections
- construction method, e.g., maximize prefabrication, allow efficient material handling, provide space and access for electrical cable and
- safety, e.g., reducing high time, avoiding some issues, provide permanent scaffolding work.

Step4: MEP design verification and MEP layout optimization based on the built building offset(height).

Mechanical, Electrical and Plumbing (MEP) design verification and partial layout optimize based on as-built building offset are the most important work in the whole MEP design work process. Because of the procurement delivery AI system. If construction deviation is within a reason able with in range, it does not matter when ignoring the work in this phase. However, in fact most of the time construction is beyond the reasonable range for tight time and extensive management, and all the design work and optimization above will become no value means nothing is done to solve the deviations. The critical work of this stage are measuring construction deviation especially in tight space area and updating existing BIM models to reflect as per built design.

III.CASE STUDY

The Center consists of four floors: one underground and four on the ground. The total investment of this project is 70 lack. It is difficult to plan the MEP co-ordination systems in the limited space using the traditional the2D CAD. BIM was determined to be used in order to eliminate spatial and functional among the MEP systems. The MEP model (see Fig.2) was designed using which is the leading software for HVAC and Electrical design Diagram.

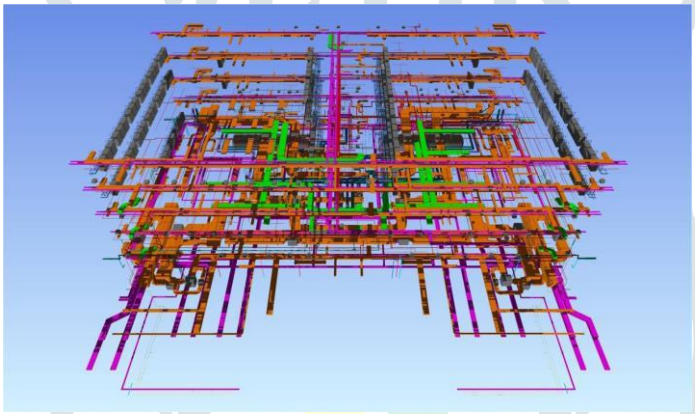

Figure 2: The MEP and Electrical design by BIM.

3.1 BIM model development

The BIM design to carry on the Mechanical, Electrical and Plumbing (MEP) design. Project design team is divided into 2D CAD modelers and BIM modelers, and they collaboration with each other throughout the whole process. BIM modular mainly uses Autodesk Revit software to create Architecture and Structure models and AUTO-CAD to create MEP models. Fig.3 shows the Mechanical, Electrical and Plumbing (MEP) model development process, 2D AUTO-CAD team use the traditional way to design and later BIM team create 3D BIM model based on its design drawings. Then, also cooperation to do clash detection and reducing some issue problem about MEP design.

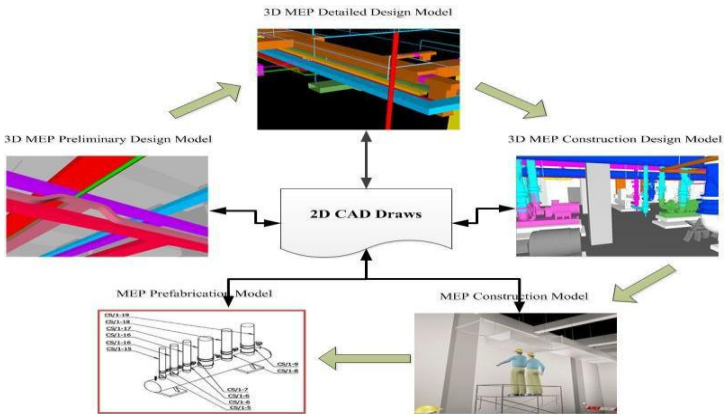

Figure 3: MEP modelling process

3.2 BIM-based MEP layout optimization modeling
BIM-based MEP layout optimization modeling every phase

1: MEP spatial layout optimization based on space requirement

Fig 4(A) shows some error among MEP systems in the design. There are some experience help designers to solve the clashes in MEP modelling,

(1) Plumbing system was firstly considered because of limited space to adjust,
(2) HVAC system usually was secondly to be considered due to the big size of components and also high cost material using,
(3) Electrical system with large cables was thirdly considered and high price,
(4) Pressure plumbing system, fire protection, control system and other some system were finally considered.

Figure 4(b) shows the result after design optimization, which satisfies to design specification and space requirement with clash free.

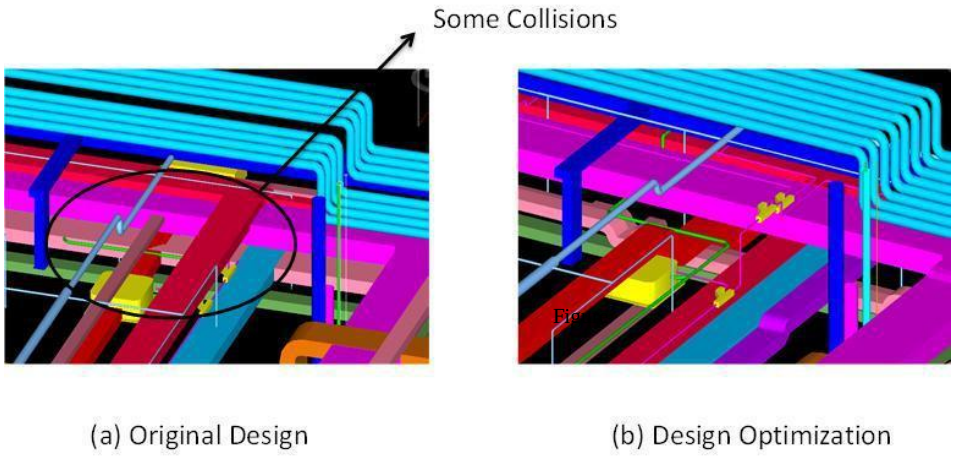

Fig 4: MEP spatial layout optimize based on clash free and space requirement

2: MEP partial layout optimization based on construction

After architects and Mechanical, Electrical and Plumbing (MEP) engineers used BIM in the design of a complex building, it is necessary for MEP contractors to implement constructability review. Sometimes MEP installed successfully largely depends on a very specific installation when the design scheme is extremely fit. Shows duct installation simulation, in view of construction method, installation space, construction sequence and staff working face, MEP contractor has done a more in depth theoretical analysis and experimental research to verify the feasibility. And also there is a lot of some large equipment in all MEP project, and how to install them correctly become very important to client. Designers take a little time to equipment installation, so there is some risk in construction, such as not enough space for equipment transportations.

3: MEP partial layout optimization based on the built building height offset:

At the beginning of Mechanical, Electrical and Plumbing (MEP) installation, the quality of the related building structure is not clear, which imposes risks on MEP systems if plans are based upon incorrect data or error data(as built in the final building), there will appear significant issues while integrating a MEP design model. At worst the restart of building modelling structure has to be moved after all. To minimize this risk, for that preparation of the planning data should be verification takes place. Thereby the current status of a building is analysis and compared to the virtual information. The goal is to verify the positions of the Mechanical, Electrical and Plumbing (MEP) system, but it also has to be evaluated and if there is any additional equipment within the workspace.

IV. Establish Relationship between Classes

More different types of connection which has a similar meaning in “I”-joint on the main-pipe and then “T”- joints to the main-pipe", "L”- joints to the branch". Although they are all relationship of connection, the objects which were described in these three connections are all different in the model.
In this paper, the Fire-fighting, HVAC, Electrical and Plumbing engineering was developed with four main classes in BIM elements, construction information requirement and storage information requirement. and construction can be described by these relationships. Fig 5 shows the MEP model of the Clash Free in BIM.

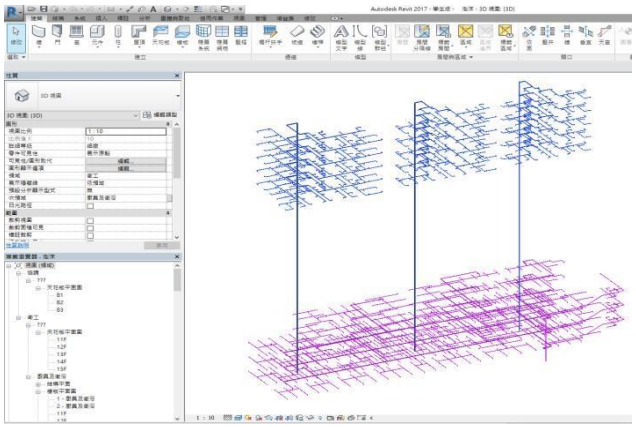

Figure 5. MEP model of the Clash Free in BIM

In order to smooth the process of developing the Mechanical, Electrical and Plumbing (MEP) BIM Model, software was used to develop the modeling automation model. It can be quickly establish the Mechanical, Electrical and Plumbing (MEP)model according to the drawing of complex system or circuit. Thus, the accuracy time and time required for MEP model can be improved.

V. CONCLUSION

As the discussion and analysis above, this paper proposes a Mechanical, Electrical and Plumbing (MEP) material management which applied to BIM. We hope that to provide more effective information forMechanical, Electrical and Plumbing (MEP) Professional contractors by means of Technologybased and information. The information not only efficiency of MEP professional contractor, but also achieve the purpose of time and cost control.

In this study, the method of Mechanical, Electrical and Plumbing (MEP) constructions was recognized to know the MEP engineering sequence. Further, the requirement of material supply which will identified to establish a framework of material management. In order to establish a modeling rule which is based on MEP material management like Fire-Fighting systems, HVAC, Plumbing and Electrical model was developed. Then the BIM model was used to be an Information modelling tool for provide required information to the Building elements.

VI. APPLICATION

(1) Design coordination problems are one of the major driving project delays, So that BIM offers detection of co-ordination and designs problems from very early project,

(2) In BIM (AI) offers improved project visualization in real time,

(3) Integration of BIM and AR proved effectiveness in terms of:

- Minimizing design errors a minimize delays and probable change orders,
- Contractor/Engineer could minimize number of personnel deployed shop drawings, especially onsite,
- Constructability and safety review will made easy
- Easy to implement, an integration of commercially available software and devices

(4) In order for the BIM model component attributes to meet the material management information requirements, Mechanical and Electrical system into three level- System, Circuit, Component. And then also established BIM properties that meet the construction requirements (Estimation, Allocation, Priority, and Testing) in pipe, wire, fitting, support, equipment and panel board. So, an information ofMechanical, Electrical and Plumbing (MEP) model was proposed.

VII. ACKNOWLEDGMENTS

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