

Process based Building Energy Model in the WWW environment

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Abstract. Building energy simulation is widely used for building performance prediction and assessment in the design process. For seamless connections between Building Information Model (BIM) and Building Energy Model (BEM), tremendous research efforts have been invested, especially with emphasis on data sharing and reuse out of BIM. However, what is lacking in the aforementioned approach is that enough attention has not been paid to the 'dynamic' design process with rapidly changing design context. This study presents a new approach, so called process driven energy simulation interface in WWW environment. Through the web interface, architects and simulation experts communicate and collaborate together for making an energy simulation model. In the paper, the real implementation of the aforementioned interface was discussed in detail. It was shown that a data driven model, meant by being exclusive of 'dynamic' design process, is not good enough for simulation and performance quantification.

Keywords: Building Information Model (BIM), Building Energy Model (BEM), Interoperability, WWW, Building simulation

1 Introduction

The information technology has continuously needed collaborations among multiple building stakeholders to obtain an optimal solution. Furthermore, a maturation of computer simulation tools in each domain has accelerated an environmental change (from a few experts having limited knowledge and information to distributed experts having professional knowledge and information) in the information technology. Under the circumstances, the importance of data sharing among different simulation models with their respective data formats is arising as one of the key issues in the field of building simulation.

In the light of this perspective, Augenbroe [1] and de Wilde [2] touched on the importance of ensuring Quality Assurance (QA) of the simulated outputs as well as roles of the design experts in each domain. In terms of data sharing technology for interoperability, they indicated that the process driven approach was more appropriate for adequate and robust decision than the data driven approach. However, the data sharing technology for interoperability is still focused on full or semi-automatic data exchanges (i.e. data driven approach) among different simulation models [3-6]. The

automatic data exchange aims to pursue a seamless interoperability through the shared building information dominated by a certain rules. However, one may wonder how the data driven approach would yield meaningful and significant results for all building stakeholders if the simulation model was only approximated by the normative building information rules. Since, it is impossible to construct a certain shared model with free error while considering physical attributes and relations in respect of all building information. In other words, it would be inevitable for subjective judgments and assumptions of a few experts to be put in due to incomplete data sharing on the complex systems [1-2].

This study introduces the process driven energy simulation interface when it transfers Building Information Model (BIM) into Building Energy Model (BEM). The process driven energy simulation interface is integrated with a dynamic building energy simulation tool (EnergyPlus) in WWW environment. The building design space is bounded by two domain regions (design, energy simulation) for easy development of the interface program.

2 Process driven energy simulation interface

The interoperability is to harmonize simulation information by using neutral or shared data model such as BIM formats (IFC and gbXML) and interface programs for extraction and elimination of simulation information. And it can reduce the epistemic uncertainty. But, it should be noted that the interface programs perform an important role for seamless data exchanges. It needs to consider data exchange scenarios including various mapping rules such as subschemas having the pre-defined logical data structures. In the study, we developed the process driven energy simulation interface in WWW environment. It is possible to reconstruct incomplete simulation information incurred from missing data according to modules in the scenarios.

The web based process model is a process based management for data exchanges as well as communications among experts in various domains as shown in Fig.1. The modules of the process model are divided into main workflows having analysis scenarios and sub workflows having unit tasks. The analysis scenarios denotes an overall flow for extracting subschemas for an energy domain under the design context, and the unit tasks denotes a management component for data exchanges and communications of experts. The experts (agents in Fig.1) can participate in the unit tasks of the each sub workflow (process in Fig.1) under the design context, and the unit tasks completed in the client computer are stored in the server computer's database (DB in Fig.1). In particular, the process driven energy simulation interface enables communications among the distributed experts by adopting the server-client system in the WWW environment. Each unit task of the sub-workflows under main workflows can be completed in parallel, and this led to reduce the bottleneck effect. And the XML schema was used for accurate and prompt data sharing and storage on the WWW environment. In other words, the completed XML schemas were transferred into input files for generating the energy simulation tools.

The entire sub workflow is made up of five modules (geometry information, specified EnergyPlus information, schedule information, internal heat gain

information, and HVAC system information), and each module is completed as follows: (1) selection of experts and requirements, (2) storage of XML schemas completed by experts, (3) transformation of XML schemas for IDF files, and (4) IDF files transfer to client computer. In other words, the aforementioned five modules were structured by data transfer of unit tasks embedded in sub workflows throughout client applications.

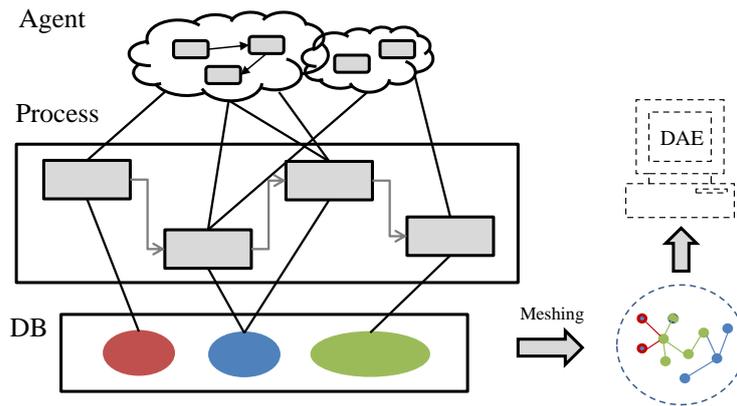


Fig. 1. Web-based process driven BIM to BEM

3 Case study

For the energy performance assessment using the process driven energy simulation interface, a five-story office in the concept design stage was chosen. The interface was implemented by five experts (one top process manager, one designer, one HVAC engineer, and two simulationists). The experts participated in their respective unit tasks predetermined by the top process manager, and multiple experts could exchange data or communications on a unit task. Fig. 2 shows web browsers displayed in the client computers implemented by sub workflows for geometry information and specified EnergyPlus information.

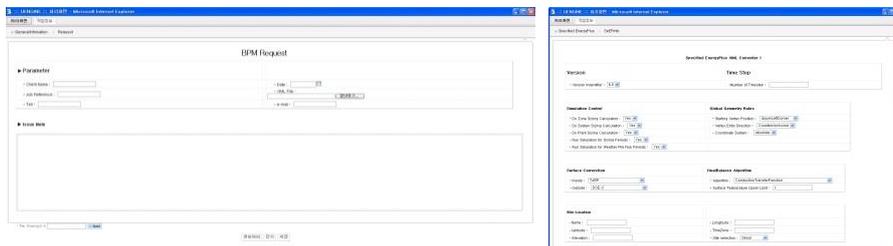


Fig. 2. Web browsers for geometry information (left) and specified EnergyPlus information (right) (displayed in the client computers)

Fig. 3 shows the monthly or hourly results of cooling and heating energy demands in the given target building. The building stakeholders can access and obtain the results on the WWW environment. The predicted outputs and information stored in the interface program can be used as sources for future interoperability works.

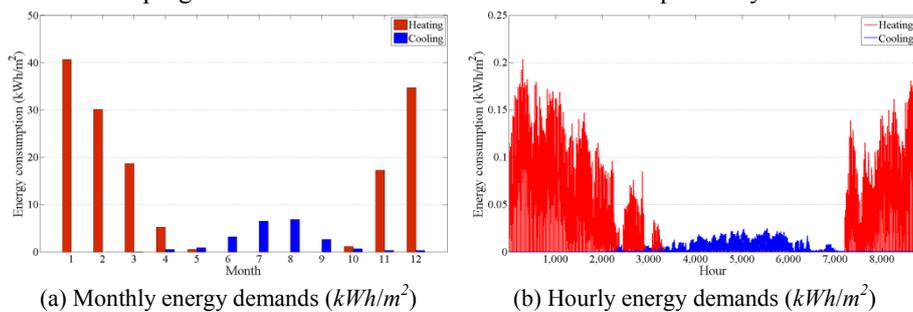


Fig. 3. Energy performance results using the process driven energy simulation interface

4 Conclusions

In this study, the issues associated with data driven and process driven approach were tackled to ensure BIM to BEM interoperability during building design process. Unlike the data driven approach, the process driven approach ensures data transfer and horizontal communications among the experts under the design context and then it can provide lessons and knowledge for future interoperability. With this minds, we developed the process driven energy simulation interface throughout a business process model in WWW environment. The interface program with server-client system provides the following merits: (1) transparent and objective data transfer environment, (2) horizontal communication environment, (3) management of the workflows on the WWW environment, and (4) reduction of bottleneck effect using parallel data transfer.

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