

Modeling For Integrated Construction System: IT in AEC 2000 Beyond

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Introduction

INTEGRATED CONSTRUCTION SYSTEM

Our construction industry has been distinct from other industries because of its extreme fragmentation in design and construction, in which a diversity of parties are involved. It is particularly true when the increasing interests are turned to the application of information technology in the design and construction. The efforts have been made over the decades, and the 'islands of automation' has not been bridged yet. No really integrated construction system has been developed at the sense that it is capable to pass information from one application to another in a way that the information required can directly be used as the input for another application. The obstacle for the integrated construction system has not been removed yet. Maybe we shall look at the thing differently.

Are the design information recorded completely? Are the implication of design which might be needed for the evaluation or analysis, externalized? Can the design information be queried as it can be done with a database system? And plus, do we have to sacrifice the freedom of designing to achieve this? Do we have the ultimate freedom to create in space?

Problem Statement

INFORMATION RETRIEVAL?

It is fine to pass design documents, either the drawings or the computer models of design, from one party to another. It is also great the kinds to interface can be developed to process the design information into the data which can be used as the input for another application. Technically, we are able to achieve some extent of automation but not the total automation. It is because that the

representation of design information has principally remains the same as that in the no-CAD system era. That is, the design documents, whether it is complete or not, is usually passed as a whole. It is up to other parties who develops or finds ways to generate the information required. The designer is usually concentrated on the design itself with little concerns on how its information required by other parties shall be retrieved for analysis. It is not saying that the designer shall really be occupied with how the design data shall be entered and organized. Rather, it is emphasized that the problem may need to be attacked from the designer's point of view because of the fact that it is the designer who records and delivers the information of design. It may be logical to say that,

- What kind of data is entered determines what kind of data can be retrieved;
- How the data is entered determines how the data can be retrieved; and
- How the data is organized determines to which extent the data can be processed;

It is seen that the input of design information becomes the crucial factor in determining what, how and to which extent the data can be retrieved. It in turn determines how well the integrated system for design and construction can be established.

PRODUCT MODELING

The effort has been made to facilitate the information flow between the design and construction. In the product modeling, it is attempted that the data model of design is built up so that the information required for the construction can be retrieved. With the information of materials and components stored in the model of design, it is possible to retrieve the information required as the input for the construction process. However, the product model relies on the information of a final design and the model of design is mostly composed of the physical components of construction. It limits its application towards the integrated system for design and construction in the way that,

- It is difficult to make modification if a major design change occurs; and
- The cost of product model has little benefit to the design itself because of its reliance on a final design and its difficulty of modification

It is expected that a design, before it is finalized, can be evaluated on various aspects as many as possible and as frequently as possible. It demands that the design information required for the analysis applications can be retrieved, which is surely not limited to the information on components. The impact of product modeling on the design process seems limited.

INFORMATION TECHNOLOGY?

Another problem with the product modeling is its detachment from the geometrical modeling system. Without it, the objects lose the ground for the interaction of each other, which is rather the essence of design activities. In terms of design modeling, it is doubtful that the problems for the integrated construction system can be solved by the information technology alone.

Proposition

DESIGN MODEL VS. PRODUCT MODEL

It is of interest to endorse the design modeling in addition to the development in the product modeling. In this contexture, the latter is covered as a part of design modeling that is at a final stage, which can be compared to the working documents in a design process. A few components are the keys for such a development:

❑ *3D objects*

It is proposed that the model of design is built up by 3D objects. It can be used to refer the design objects ranging from the conceptual ones such as the space or the wall to the physical components such as the stud or the brick.

❑ *Active model*

It is expected that the model is free for the growth and change at any degree. It shall be an active one rather than a static one.

Research Issues

To facilitate the information retrieval in the design and construction process, the following areas need to be studied and developed:

- Studies on the construction design
- Integration of geometrical modeling and object-oriented technology

STUDIES ON THE CONSTRUCTION DESIGN

On the theoretical aspect, the fundamental studies on the construction design needs to be carried out so that the model of design can be built up in a way that the information required can be retrieved. There are a few aspects we can look on:

❑ *Objects and relationships*

It is understood that the model of design is composed of objects in a certain of relationships as the design does. How much do we know about the objects and the relationship of objects? How can the relationships be established in a design model? Are they the intrinsic relationships belonging to the objects or the external ones assigned to them? To which extent the design information can be modeled?

❑ *Decomposition of design*

A building design is a complex which needs to be decomposed so that the model of design can be built up. In which criteria shall a design be decomposed? Any why? Can the modeling keep the consistency under such criteria if any? Can the duplication or the redundancy of information can be avoided?

❑ *Identification of objects*

Another crucial development is how the objects can be identified in the model of design so that each of object can be retrieved upon a request.

It is worthwhile that the issues can be clarified, at least, theoretically, which will ultimately benefit the development of the integrated system for design and construction.

It is suggested that it is necessary to integrate the geometrical modeling with the object-oriented information technology if the fully integrated system for construction is projected. But is there such a possibility? And how if yes? A great deal of work needs to be carried out in order to achieve such a goal if it can be justified. Studies on both the theoretical and the implementing aspects are expected.

Research Interests

For years, I have become associated with and conducted the doctoral research work in the Groupe de Recherche en CAO, Faculté de l'Aménagement (Faculty of Environmental Design), Université de Montréal since I joined it in the summer 1992. My research interests lie in the development of the methodologies of design modeling which ultimately serves the development of integrated system for the design and construction. Over the years, I have kept interested in the identification of problems for the development of the integrated construction system and in the development of strategies and methodologies to the solutions. It is attempted that the design modeling can be developed that first the model of design is allowed for the growth and change and second the information required for applications can be retrieved.

Recently my work turns on the integration of design modeling and the object-oriented technology which has widely been applied in the product modeling. It is expected that, on the one hand, the research on the design modeling shall be more advanced. On the other hand, the integration of geometrical modeling with the information technology shows the potential for the integrated construction system, which will ultimately offer the opportunities for the computerization of our industry. The collaborative research may enable such a possibility.

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