AN OBJECT-BASED BUILDING PRODUCT MODEL FROM MODELING TO DOCUMENTATION

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ABSTRACT

In Korea, construction industries have started to recognize the importance of the conceptual model of building objects to integrate various information from different views on a project. An object-oriented model was proposed and implemented partially. The implemented system of the model at this stage aims at the automatic generation of two dimensional drawings from three dimensional objects even though the objects defined in the system carry more information than just geometric properties. Information regarding structural analysis, construction planning, and scheduling is represented in the model. It was concluded that three separate modules need to be developed to cover the most popular structural types of current projects : reinforced concrete, steel, and shear wall. However, these modules share many objects which represent architectural components like non-bearing walls, openings, stairs, rooms, doors and windows. To be a flexible design tool, an input mechanism for a model should facilitate a three dimensional CAD system. Once objects are defined and placed through a user interface in a CAD environment, the system creates objects which in turn are checked for consistency. There are access functions to retrieve data for other application programs.

INTEGRATION AT CONSTRUCTION COMPANIES

The need for the integration of jobs at engineering and construction companies in Korea has increased ever since the CAD system has become an important tool for drawing documentation. They include briefing, preliminary and detailed design and engineering specifications. For many job locations, computer software is used to solve their problems at hand. These computer programs are pretty powerful in their domain. However, the overlapping data input procedure of information for various programs has not been eliminated. This has the effect of lowering job productivity from the viewpoint of construction project management as well as the possibility that this missing information might raise the danger of unprecise design and poor assembly of building components.

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Since CAD systems became the vanguard of computerization at architecture and construction companies in the early 80's, the integration of necessary information for projects has been the major, if not the urgent, issue. However, the approach toward integration is not based upon the comprehensive consensus of all the departments involved, especially the architectural design part. The immediate goal of integration in the engineering and construction companies is to build an engineering database and it is therefore initiated by the structural engineering department. However, due to this reason, the building model has not been completely represented by other departments. The reason for this tendency is that construction companies are contractors as well as engineering designers. This adversely affects the modeling capability of building spatial organization. This will jeopardize the whole project at the later stage of the process because any change in the design of the building requires the manual change of entire documents. Therefore, a product model of a building is being suggested which is not possibly complete.

THE PRACTICAL APPROACH OF THE DEVELOPED SYSTEM

This project of a building model has been carried on for three years. The project is still in its early stages. Its eventual goal is to integrate the process of architectural design, engineering design and specifications and construction activities by providing building information for individual programs to solve problems during the process. Though it is not a complete list covering the programs in use, it includes three dimensional modeling, two dimensional drawings, quantity and cost estimation, construction scheduling, structural analysis, space layout and organization. Here space layout and organization means the knowledge of the recognition of rooms and their spatial relationship.

The implemented system adopts a commercial CAD system which can be expanded for object creation and management. The AutoCAD program is used for the input and output of geometric representation of objects. However, the system can have different CAD programs for the display of these objects. The system utilizes the conceptualization of both space and building components like constructed objects: walls, slabs, columns and beams. To accomodate the representation of space and constructed objects, recently proposed and developed data models of building information are reviewed and adopted as a basis for the research. The reviewed data models are IDM from European community, RATAS from Finland and EDM of UCLA. However, these models only provide the initial scheme to build a more practical model which can be implemented in an object-oriented CAD environment. At any rate, they were an invaluable resource

in developing these concepts and the prototype computer model.

THREE MODULES OF THE BUILDING PRODUCT MODEL

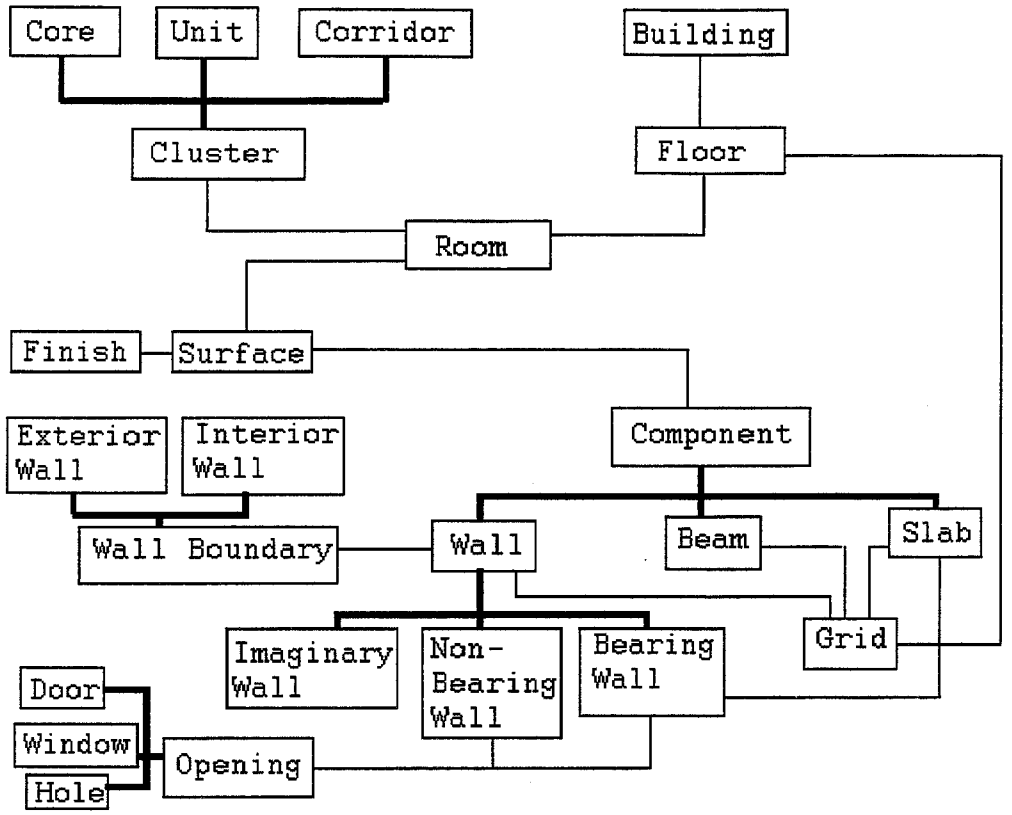
The computer models are classified into three groups by project types which are very popular in Korea. They are rigid frame structures of reinforced concrete, joint frame structure of steel, and shear wall structure. Rigid frames are for small to mid-size buildings of all kinds: commercial, institutional, government, hospital, and even houses. For large and tall office buildings, steel frames are used due to their relatively short construction duration time. Shear wall structure is utilized for multi-family housing projects.

The housing shortage and its supply has been the most serious problem since the Korean war, and it has been a major political and social issue until now. The shear wall types were adopted as multi-housing high rise apartment building structures since the 1960's. Because of its economic and engineering advantages over other types, it established its position as the unbreakable solution for the public housing supply problem, and private construction companies naturally followed this trend. Therefore the housing project has been explicitly the independent design type. The computer utilization for the documentation of these apartments are highly regarded as useful.

It was decided that three separate, but sharing many aspects, modules were developed to model three typical structures built in Korea. These three modules share the same objects for spatial layout and organization. Their physical constructed objects are defined in their respective modules mainly because they are not mixed in use together. Also, the implemented system has micro-computers as a workstation with limited memory and power of a processor. In the future it could be merged into one module that can cover all three types.

A DATA MODEL FOR AN APARTMENT BUILDING IN KOREA

The defined objects and their relations for a shear wall structure apartment building are shown in the picture. This model is developed to support designers with the way a flat unit is designed and developed, and its horizontal multiplication for a floor and vertical multiplication for a building. For example, an object cluster is defined in order to group a set of units which are not identical. Such a cluster usually combines two units and a core of an elevator with a hall. Another cluster consists of an elevator with a hall, and a corridor to which units of the same floor open. When feasibility of a project is studied, this grouping of objects are very efficient in terms of time


Core
Unit
Corridor
Building
Cluster
Floor
Room
Finish
Surface
Exterior Wall
Interior Wall
Component
Wall Boundary
Wall
Beam
Slab
Imaginary Wall
Non-Bearing Wall
Bearing Wall
Grid
Door
Window
Hole
Opening

and cost for the study. Also this grouping strategy saves physical memory space in the computer since the system needs detailed information only for one unit or cluster to be multiplicated. Remaining units and clusters keep their locations with orientation. This strategy complies with an object oriented approach of class and instance hierarchy.

THREE DIMENSIONAL MODELING AND USER INTERFACE

For users' convenience, the reference grid system is adopted to place objects easily in three dimensional space. A designer draws base grid lines, and then defined objects are placed according to their relative locations from the grid lines. If a designer changes a grid line, the system will calculate the position of vertices when asked for the display of the objects. Therefore much of the information for display is calculated only when needed. This method improves the search speed through the database for objects in question.

Another feature the system has developed is automatic room recognition. The system searches enclosed walls to recognize rooms. For this, an object called an imaginary wall has been defined. It is a wall without thickness which separates one space from another for different activities. A designer will draw a grid line for the imaginary wall, but it will not appear in the display of a model. There are a number of grids in the system: planning grid, structural grid, mechanical grid, energy zoning grid, etc. The knowledge for checking the conflicts between these grids should be embeded into the system. At this moment the system does not provide any mechanism for this.

CONCLUSION

The system primarily aims at the automatic generation of two dimensional drawings and bill of materials along with data interface for other application programs of design analysis. Especially for the shear wall structure buildings, it has been quite a successful and powerful design tool. For rigid frame buildings, geometric representation of spaces and constructed objects has to be refined to accomodate three dimensional and two dimensional properties for display purposes. For the automatic generation of two dimensional drawings, it is required that the connection part of different objects should be defined clearly and formally.

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