Maintenance Information Management, Based on a Step-Related Building Product Model

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ABSTRACT

The property management phase of the construction process comprises operation, maintenance and minor alterations. Property management, by its very nature, is responsible for the greatest volume of work in the product life cycle of a building and it is therefore of great importance to utilize IT in this work. An efficient way of doing so is to use a Building Product Model as a core in the information management system.

A digital Building Product Model contains a logical and general description of the product "building" and its creation. The complete Building Product Model should contain all relevant information needed for the design, production and management of a building. The data model created and used in this project is based on the BSAB/SfB system for classification and is developed with the methodology and principles of the STEP standard.

The BSAB system contains product classification tables. It is a tool for the arrangement of technical and financial information in documents and databases. The SfB system is the predecessor of the BSAB system and is still in use in many countries. STEP is a series of ISO Standards for the Exchange of Product Model Data. STEP is a specification for communicating product information at all stages in the product life cycle. The fundamental components of STEP are product information models and standards that are used as means of exchanging information corresponding to these product models.

In this project, a conceptual scheme of a building is implemented into an object-oriented database and a suitable user interface is created. This database system is then used to handle information about a real building in some typical property management tasks.

Key Words

information technology; property management; STEP standard; building product model; classification

The Construction Process

The term "construction process" is the generic designation of all activities

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which are employed to create and maintain buildings, plants or other construction facilities. The construction process can be divided into the following phases: programming, design, tendering, production and management. Construction activity, apart from new construction, also comprises renovation, alterations and extensions. In the construction process, resources are converted by activities into results (products).

The construction process can be characterised by the following statements.

- It extends over a long period of time (usually at least 50 years).
- It is a complex and iterative (information) process.
- It has many participants, all with definite roles and from many different firms and organizations.
- Almost every building is unique.
- The team creating the building is unique.
- The building has a long life cycle and this implies high demands on appearance, quality, economy and functionality.

During this process, a very large quantity of information, both alphanumeric and graphic, is processed, exchanged, updated and deleted.

Building Facilities Management

The property management phase comprises the planning and carrying out of operation and maintenance work, service to the tenants and administration of these activities. The management phase also includes minor alterations.

Operation is the effort required to supply the property with heating, water and electricity and to maintain both the outside and the inside of the building.

Maintenance is the work needed to preserve the function of the building, the technical and aesthetical standard and the value of the building.

During the management phase, different types of information is used. Administrative information is needed for planning, organizing, guiding, coordinating and controlling the property management work. Financial information is needed for planning and controlling the economy of the property management work. Important components are calculations, budgets and accounts including controlling. Technical information is needed for carrying out the operation and maintenance work.

The primary subjects of the property management work are the building and its physical and spatial components. A Building Product Model can be seen as a standardized and integrated structure of the information about a building and its components during their whole life cycle. The data model created and used in this project is based on the methodology and principles of the STEP standard and the classifications from the BSAB/SfB system.

The STEP Standard

Through efforts by IS0, International Standards Organisation, a series of standards (ISO 10303) for product data representation and exchange has been developed. They are informally known as STEP. STEP is the acronym of STandard for the Exchange of Product model data. STEP is a specification for communicating product information at all stages in the product life cycle. The product information covers all aspects of product description and manufacturing specifications.

STEP is divided into parts, each of which is formally a separate ISO standard. Part 1 is an overview and contains the fundamental principles. The following description of STEP is quoted from part 1.

"ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange but also as a basis for implementing and sharing product databases and archiving (ISO CD 10303-1, 1992)."

"The information generated about a product during its design, manufacture, utilization, maintenance and disposal is used for many purposes during that life cycle. The use may involve many computer systems including some that may be located in different organizations. In order to support such an environment, organizations need to be able to represent their product information in a common computer-interpretable form that is required to remain complete and consistent when exchanged among different computer systems (ISO CD 10303-1, 1992)."

The SfB/BSAB Classification Tables

The BSAB system contains product classification tables that are generally accepted in Sweden. The product classification tables of the BSAB system are used for the arrangement of technical and financial information in documents and databases. The present generation of the BSAB system contains two product classification tables - Product Tables 1 and 2. These two tables contain codes and headings for the components used to make up a project or structure.

Using Product Table 1, civil engineering works, buildings and building services installations can be classified with respect to the materials the components contain and the type of labour required for the production of these components. This table contains objects such as structures and installed equipments. It is also used as a principle for division of the (AMA) General Material and Workmanship specifications. Detailed technical specifications are usually drawn up with reference to AMA.

Using Product Table 2, earthworks, buildings and building services systems can be classified with respect to the technical functions of their components. This table contains objects such as elements of civil engineering works, buildings and building services installations.

In the Building Product Model, we have used the 1983 BSAB system as a basis for the definition of the object classes in the object-oriented database. In order to do this the system had to be supplemented in two ways:

1. Provided with new headings, so that the system contains all the elements of modern building.
2. Provided with a completely new table for different types of spaces in different types of building.

The first supplement involved adjusting the present BSAB tables, especially the P2 tables. The second supplement involved creating a new table (matrix) for classification and coding of spaces, with a construction analogous to the present BSAB-system P2 tables. The buildings and spaces are classified on the basis of their main application.

The Actual Model

Modelling means that a part of reality (Universe of Discource) is divided into distinct objects (entities). These objects possess various properties (attributes) and they may stand in different relationships to each other. Certain objects are composed of other objects. Objects that display sufficient similarity are grouped into classes (types). Some types are more general than others. To represent this the concept of generalization between classes is used.

Abstractions are used to classify and generalize concepts in the model. Abstraction means that you disregard certain aspects of a given concept in order to focus on other aspects.

Objects related to buildings are used during the different phases of the construction process. To support the information process you must handle objects of different complexity and classes at different levels of generalization - specialization. That is why the most important hierarchies in a complex conceptual model are its object hierarchies ("part-of" hierarchies) and its class hierarchies ("kind-of" hierarchies).

During the property management phase, you handle information which is a combination of more schematic and general type about the whole building and detailed information about certain components or systems of the building.

To support the information process, the model used must comprise of physical objects and spatial objects and different structures of those.

The actual model used in the project is schematically described in Figure 1. It consists of five main parts: a model core, three different catalogues and a part handling the construction phase.

The model is developed according to the methodology and principles of the STEP standard. A more detail model is described in Figure 2.

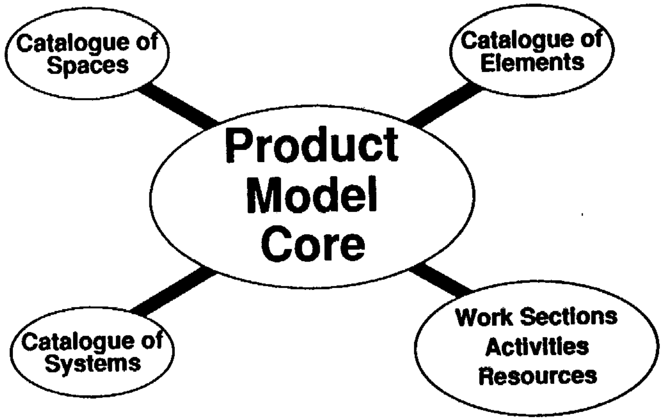

Figure 1. A Schematic Picture of the Implemented Building Product Model

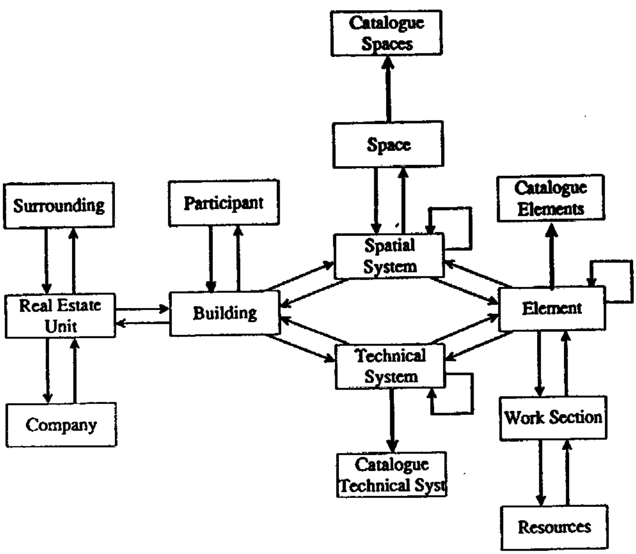

Figure 2. A More Detailed Picture of the Implemented Building Product Model

Database Implementation

The model is implemented in a real database system. Relational databases have some major disadvantages for this implementation. They handle only simple data types, *ie* numbers and strings. They have quite a restrictive way of handling couplings between entities. These drawbacks make it difficult to implement a product model.

In the new generation of databases, the object oriented databases, the structure could almost be the same as in an object oriented conceptual model. In an object oriented database, the entities are the same as the entities in the model. The entities of the database contain both (complex) data and referential methods. The database entities have a well-defined interface such that external programs can be connected to the database entities as methods. It is for these reasons that we have chosen to implement the Building Product Model into an object oriented database.

The Prototype Work

The purpose of the prototype work is to demonstrate the idea of using a neutral Building Product Model for information handling during the property management phase of the construction process.

The prototype consists of the following parts:

- an implemented building product model
- relevant information about a real building
- an object-oriented database system
- some real typical property management tasks.

The tasks that we analyze in the prototype are as follows:

- a tenancy agreement
- a room climate calculation
- a minor reconstruction
- an operating instruction
- maintenance planning.

In the tenant agreement the areas in question are specified on a floor plan and the rents are calculated from information, eg different cost figures, that is stored in the building database.

The room climate calculation is a heat balance calculation for a specific room in the building. The heat supply and the heat loss are calculated. Both data and methods used in the calculation are stored in the objects of the building database.

The minor reconstruction means a change in the lay-out of a part of one floor in the building. These changes also means some changes of connected building services in this part of the building.

A typical operating instruction is a card with short instructions, both graphical and alphanumerical, that describe how to operate a building services installation system.

For maintenance planning you need different information about the house. This information should be in the building database.

Hopefully, the idea with a neutral building product model as a kernel in the information system could be vizualized for both information system users and information system developers.

CONCLUSIONS

By structuring the information handled in the management phase in accordance with the object-oriented Building Product Model, several advantages are obtained. These advantages are:

- You can better integrate different types of information eg technical and economical information.
- You can handle geometrical information together with alphanumerical information.
- You can combine data and methods into integrated "building objects".

Eventually this means that you can apply life cycle thinking to the construction process. You can also obtain better information to support decision making.

Last but not least, the work with the prototype has given a lot of valuable experience to the future work of trying to create a complete Building Product Model.

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