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Integrated Computer-Aided Building Design and Production

Conception et production intégrées et assistées par ordinateur

Integrierte computerunterstützte Planung und Ausführung von Bauwerken

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SUMMARY

The aim of the Finnish development is the national computer integrated construction management system. The results of the work include the model of computer-aided design process and the systematics of public databases, design database, data transfer, design documentation and systematics of building. The object-orientated hierarchical systematics serves all subsystems. The hierarchical, modulated technical systems of building fulfil the needs of compatibility between design and manufacturing process in the new generation of industrialised prefabricated building technology. Information transfer between subsystems of design and production is concretized through data systematics and conversion programs.

RÉSUMÉ

Le but de développement en Finlande est la conception nationale de constructions assitée par ordinateur. Les résultats du travail comprennent le modèle du processus de la conception assistée par ordinateur et la systématique des bases de données publiques, des bases de données de la conception, du transfert d'information, de la documentation de la conception et la systématique de la construction. La systématique hiérarchique et orientée vers l'objet sert à tous les sous-systèmes. Les systèmes de construction techniques, hiérarchiques et modulés correspondent aux exigences de la compatibilité entre les processus de conception et production, qui caractérisent la nouvelle génération de la technologie de construction industrialisée et préfabriquée. Le transfert d'information entre les sous-systèmes de conception et production est concrétisé par la systématique de données et par les programmes de conversion.

ZUSAMMENFASSUNG

Das Ziel der finnischen Entwicklung ist die nationale integrierte, computerunterstützte Planung von Bauwerken. Zu den Arbeitsresultaten gehören das Modell des computerunterstützten Planungsprozesses und die Systematik der öffentlichen Datenbank, der Datenbank für Planungen, der Datenübertragung und der Planungsdokumentation sowie die Bausystematik. Die objektorientierte hierarchische Systematik dient allen Subsystemen. Die hierarchischen, modulierten, technischen Bausysteme werden den Ansprüchen der Kompatibilität der Planungs- und Herstellungsprozesse gerecht, die der neuen Generation der industrialisierten Fertigteilbauweise eigen sind. Die Informationsübertragung wischen Subsystemen der Planung und Herstellung wird durch die Datensystematik und Konversionsprogramme konkretisiert.

1. MODEL OF THE COMPUTER INTEGRATED CONSTRUCTION PROCESS

The ongoing development process in Finland is aimed at the computer-integrated construction management system named "RATAS". The system will create the Finnish national open, distributed design, production and management system. The integration is achieved through the data transfer between different subsystems and common data systematics.

The development has been carried out in two projects: "Contrete element CAD (BEC)" and "Computer-aided building design and construction management system (RATAS)". Close cooperation between researchers, consulting engineers, companies and associations has been applied.

The computer-integrated construction includes the materials processing flow and the supporting information processing flow. The compatibility of the material process and information process is achieved through the technical systematics of building. The technical systematics is described as a modulated hierarchical system, which serves both the material process and the information process. The computer-integrated process is described in Figure 1.

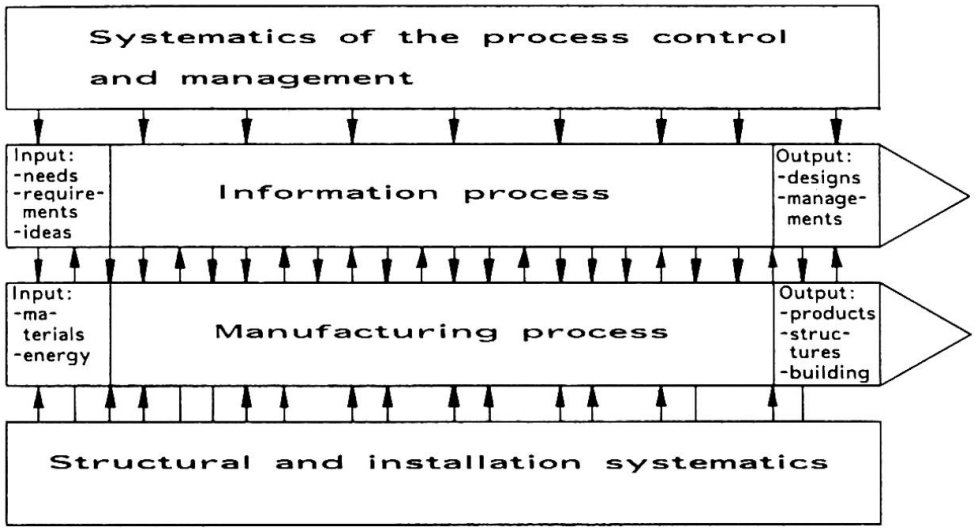

Fig. 1 Computer integrated construction described as information and material process with the support of building systematics

The national CAD system has been developed through projects in 1984-1987. The development will continue with pilot projects for practical applications beginning from the year 1988.

2. COMPUTER-AIDED DESIGN PROCESS

The aim of the design process is to produce successively the design database which includes all the information needed at the different phases of construction planning and production. The needs of all the parties of construction must be fulfilled at the right moment.

The accumulation of the design database must follow the development of the production process. Some information must be transferred also from the systems of contractors into the design database as back-up material of design. The information transfer between the design database and the systems of contractors is presented in Figure 2.

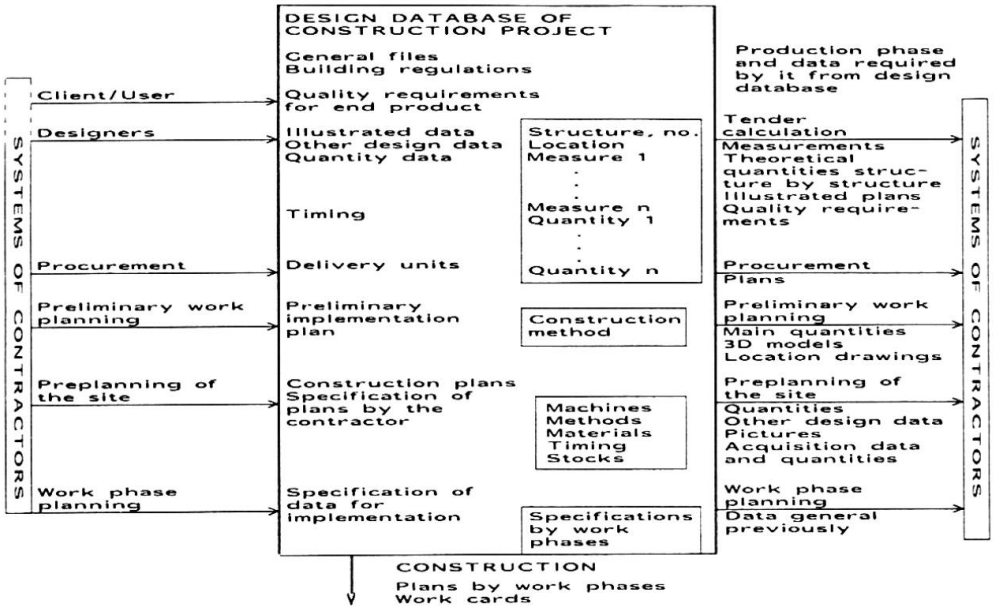

Fig. 2 Information transfer between the systems of contractors and the design database.

The second important partner in production is the element industry. The BEC (Concrete element CAD) -design system has been developed for a subsystem of the national CAD-system. The system scheme is presented in Figure 3. The BEC-system is connected with the design database system as well as the production planning systems at the element factory and on site.

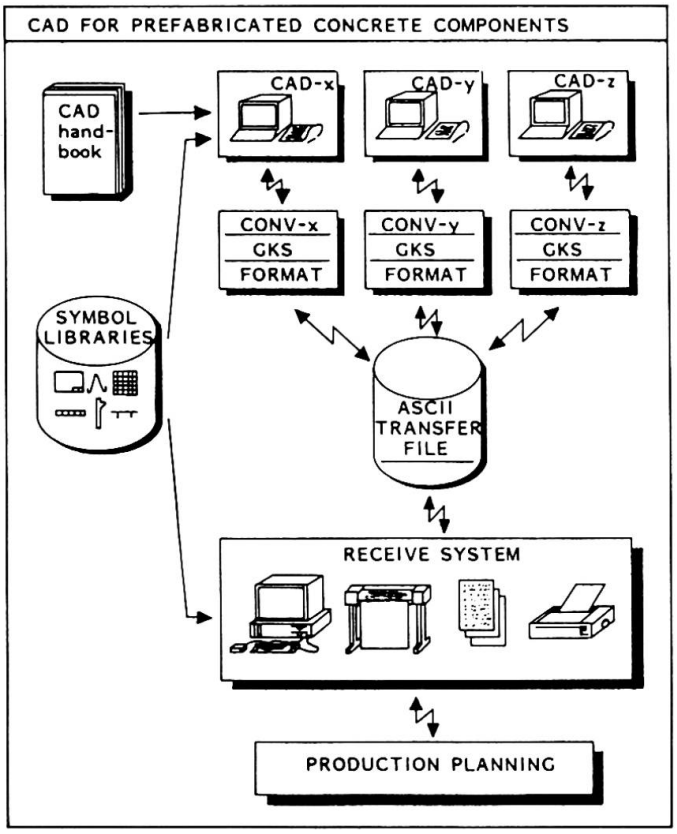

Fig. 3 Principle of the Finnish concrete element CAD-system (BEC)

3. SYSTEMATICS

The most important part of the development of the national CAD-system is the solution of common systematics, which guarantees the logical production of information and the fluent data transfer between partners in design and production process. The subsystematics are included in public databases, design database, data transfer, design documentation and systematics of building.

3.1 Systematics of public databases

Public databases include a vast amount of information on public rules, standards, products, design methods and manufacturing methods. Therefore an effective searching file of databases is proposed to be developed.

Public databases will be maintained by manufacturers and public authorities. Some databases will be established in computerized form and made available to users as diskettes or other media. A survey has been made on existing traditional databases. Traditional centralized public databases can hardly be successful in a design environment. With new technologies like CD-ROM memories the distribution of databases can be solved.

Most potential area seems to be product information published by manufacturers. Today printed leaflets are commonly used and distributed to designers.

Other areas are various design guides and codes. It is felt that a standardized format for knowledge in the sence on facts and rules of expert system technology is not yet realistic. Some guidelines only shall be defined to allow future adaption of expert system technology in the interpretation of design rules.

The formats of the public databases should be the same as for data transfer in order that the information could actually be extracted from the public data base and inserted to project data bases.

3.2 Systematics of design data base

The goal of the systematics is to define an overall logical data structure which makes it possible to build the design database by distributed designers and to meet the needs of different partners at the building process at different phases of the process.

Trying to cover various aspects of different organizations as well as time dependencies in a building project soon leads to extremely complex definitions. Therefore it was quite natural to select an object-oriented approach to the definition methodology. Objects are identified and all aspects of them are studied and defined without the necessity to keep track on the overall data architecture at the same time.

It should be noted that the adopted concepts are used as a definition methodology only and do not limit the development tools of practical software systems. Object classes make up hierarchical structures. Properties of a class are inherited by all it's subclasses. Besides being a convenient tool in the association of properties to objects object classes may also be rel-

ated to various classification codes. In order to avoid complex codes we try to limit the number of parent classes that a class may have to one. Thus the classes are organized into a simple hierarchy specific to a project. Objects can be physical "things", spatial rooms, activities or abstractions.

An object may belong to one or more object classes.

Objects make up networked structures: an object may have several parent and child objects. The object hierarchy defines the topology of the whole project. The purpose of this topology is mainly to aid the designer himself during the design process. Topology can also be used as data search path.

Properties of objects are defined by values of attributes.

The existence of an attribute can be inherited through class membership or it can be defined individually for an object.

Most objects have attributes related to time. Rules on the interdependencies of the values of such attributes define the building planning process.

3.3 Systematics of data transfer

The goal of the systematics is to define file formats for the transfer of various types of data between computerised systems.

All transfer formats consist of visible ASCII characters. For some data types including vast amount of information the information is packed and not readable by human in order to compress file size.

The formats are defined separately for text array or table , vector graphics and raster graphics. Guidelines for the product model, geometric model and knowledge as expert systems are also presented. Comments and suggestions about the use of bar codes e.g. for printed product descriptions in various documents are given.

The data is fransformed into the transfer file with the conversation program of the sender and again into the receiver file with the conversation program of the receiver. The conversation programs have been developed until now for six different computer and program systems.

3.4 Systematics of design documents

The systematics is developed for the design documents of all partners in the building process but especially for the production in element factories and on site.

The task of this subproject is to formally define the logical contents of documents that are needed during the project by different parties. This evaluation should be independent of the format of present or future documents. Guidelines are outlined for future design practices so that the potential benefits of CAD could be better utilized. Also changed responsibilities of various parties due to new design practices are suggested. For demonstrative purposes some new types of sample documents are prepared.

3.5 Systematics of building

The systematics of building serves as the link between the design and manufacture. The goal is to allow economical and effective manufacture without remarkable limitations for the design. For the new generation of Finnish industrialised building technology, the hierarcical modulated systematics is developed. The systematics is the same for all technical and architechtural systems of the building including structural system and installations. The physical systematics of building is fully compatible with the systematics of the design data base of CAD presented above at point 3.2.

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