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FROM INFORMATION TECHNOLOGY TO BUILDING SYSTEMS AND PRODUCTION PROCESSES

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1. Introduction

Recent developments related to computer integrated construction (CIC) in Finland are summarized. In separated efforts several subtopics of CIC have been developed. New ideas from information technology have also inspired simultaneous developments of building systems and production processes. A synthesis is now being made in order to create an overall model of a CIC process. This model is expected to provide a common basis of communication between professionals and to identify necessary organizational changes in building process as well as required further developments.

2. Trends of CIC in Finland

Prefabrication is extensively used in the Finnish building industry due to reasons like: post-war rebuilding, rapid industrialization, cold climate and lack and high cost of labour. The early adaption of modular dimensioning has contributed to the large portion of prefabrication. About 80 % [1989] of all multistorey buildings are made of precast concrete elements. Like in many other European countries, steel frames have newly become increasingly popular in office and commercial buildings. A new step of development is now foreseen in the form of growing adoption of computerization and automation.

Some of the main driving expectations to the CIC development are:
- Increased international competitivity upon the integration of European markets after 1992.
- Better manageability of building projects.
- More open possibilities for competition at various phases of projects.
- Availability of information about buildings over the life-cycle.
- Better motivation of industry to innovation, product and process development.
- Increased use of ready-made products and prefabricated units.
- More flexible organization of projects.
- Increased reliance on subcontactors.

The following factors contribute to the achievement of these expectations:
- Vision of future and strategy for it.
- Understanding and skills of information technology.
- Information modelling methodologies.
- Design systems (CAD) with product model features.
- Data exchange standards and conversion software.
- Electronic data interchange (EDI) services.
- Public data bases of products, services, geographic information, etc.
- Open building systems (compatible product types and building units).
- Classification systems.
- New products and production processes.
- New organizational patters.

3. Information modelling

Internationally known methodologies for information modelling have recently been adopted in national development efforts. These common methodologies are expected to provide better mutual understanding at both national and international level. The main methodologies are:
- SADT for functional modelling,
- IDEF1X for data modelling.

Since many previous Finnish developments in the area of product modelling are object-oriented it is likely that also other methodologies than IDEF1X (which is relationally oriented) will be applied e.g:
- NIAM: a diagramming methodology,
- EXPRESS: a formal data modelling language developed and used within ISO/STEP for the specification and maintenance of the STEP-model.

4. CAD data exchange

Due to the absence of operational solutions for communication between various CAD and MIS systems a national data exchange system "BEC" was developed in the mid 1980's. The system is based on neutral file formats for 2D-drawings, alphanumeric tables and product model data bases.

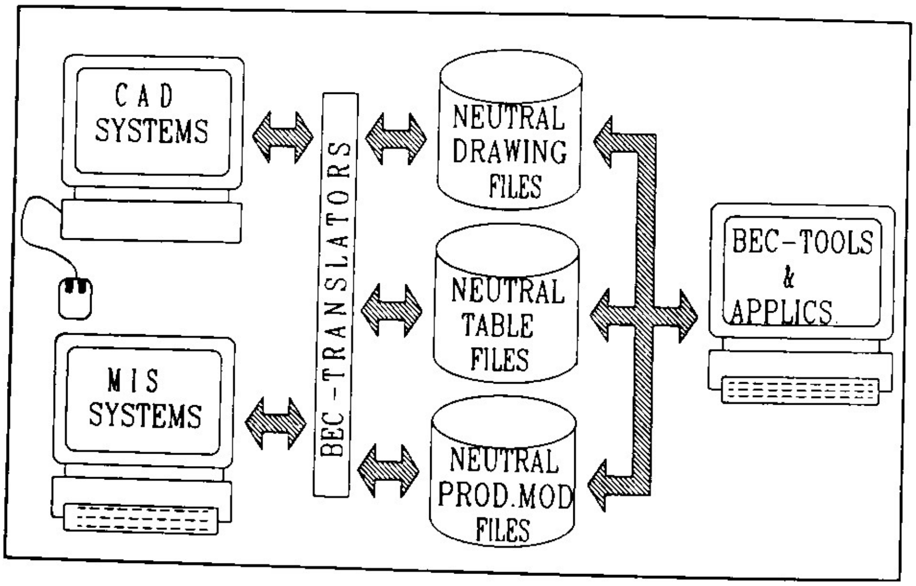

Figure 1. BEC data exchange system

Several software products supporting BEC data exchange are available to users for purposes like:
- translation from a specific system to the neutral format and vice versa,
- previewing,
- plotting,
- extraction of alphanumeric data from drawings,
- various manipulations of drawing, table and product model files,
- software tools for the developers of applications or translators.

BEC-system has been widely adopted in computer integrated design projects as well as in several non-building application areas. Besides Finland BEC is also used in Sweden and Norway. The most common application is the exchange of CAD-drawings. So far "higher level" data interchange using tables and product models is used in the design-manufacturing process of precast concrete only.

5. Product model developments

Simultaneously with the proliferation of CAD-systems it was widely reqognized that effective integration will not be possible at the level of currently dominating CAD-technology. Instead of computerized documents which are only human-interpretable emphasis should be on computer-interpretable information.

A concept of future computer integrated construction process was outlined in a project called RATAS. The main elements of the concept are:

- Public databases containing project-independent data such as product information, technical solutions, rules, codes, regulations etc.
- Data transfer between various computer systems.
- Conceptual object-oriented building product model; buildings are decribed as compositions of "objects" which have proterties and relationships with other objects; application oriented implementations of the conceptual model may be derived by specifying the "classes" and "attributes".
- Creation, storage and retrieval of all relevant information in a product model data base: during construction process any new piece of information is stored into a data base by an author e.g. designer. Information may be extracted from the data base by various users (readers) who may define the contents and presentation of information according to their specific needs. The opportunities of these new possibilities to the construction process were illustrated.

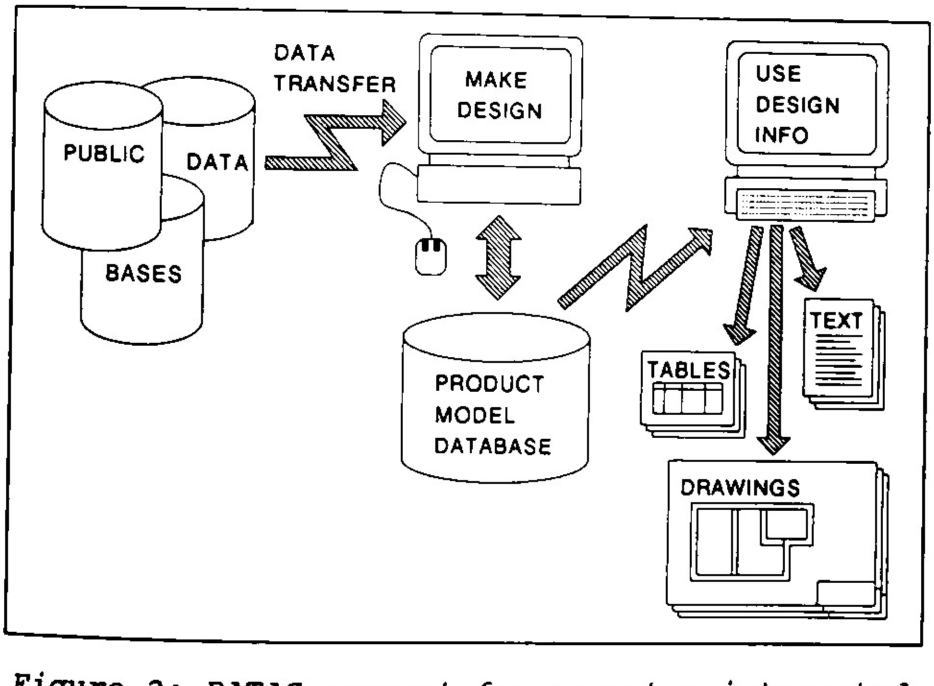

Figure 2: RATAS concept for computer integrated construction

The RATAS concept has been practically applied in e.g.:
- specification of data exchange file formats,
- enhancement of existing general purpose CAD-systems by implementation of some features of the conceptual product model,
- development of new object oriented CAD-systems for special applications like concrete and steel structures,
- development of classification systems,
- establishment of services to provide computer-readable public data bases.

6. Building systems

An open modular building system called TAT has been developed by the contruction industry. In principle the system is based on composition of buildings from units at various hierarchical levels:

(1) building,
(2) sub-building,
(3) module,
(4) component and
(5) part.

At all levels the units may serve functions of one or several systems of the building. At the top levels the degree of standardization is lower and thus the freedom of designer less restricted. Typically components would be used in a factory to assemble a module which is delivered to the building site as one unit.

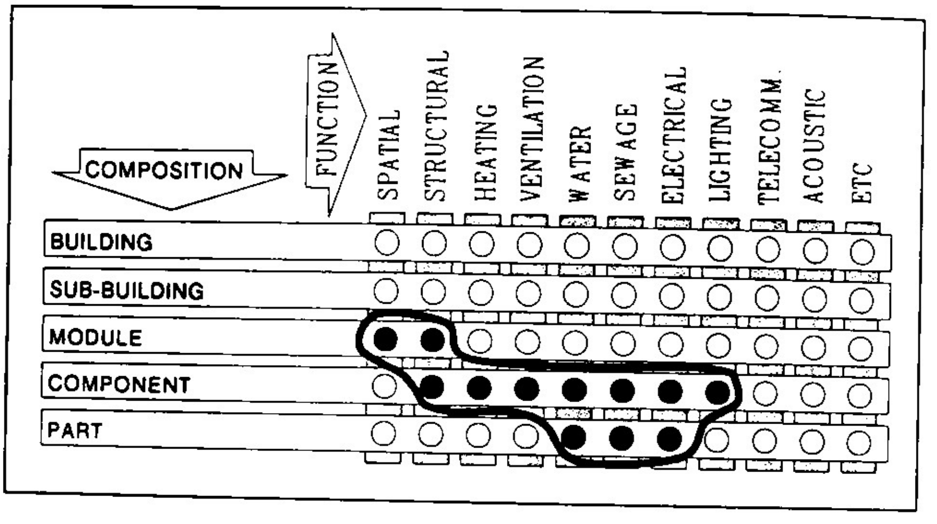

Figure 3: TAT building system (a possible configuration of a prefabricated module is shown as an example)

The target production process is based on:
- automated production of standardized types of components in factories using flexible manufacturing methods,
- production of modules either by prefabrication in factories or by assembly on site,
- minimized installation effort on site.

Compatible types of components, modules and connections make up an open building system. Various companies in the building industry introduce alternative product types which can be combined with a large variety of other products within the common dimensional and tolerance system.

7. Public data bases

First attempts are now being made by various organizations to create public databases including CAD-symbol libraries, design guidelines, product information etc. These libraries are made available to users first diskettes. Electronic retrieval from central data bases will be the next step. In longer term distribution on CD-ROM disks is anticipated. So far the logical level of information is typically text and/or 2D graphics.

8. Production process

Traditional organizational structure of building projects is not optimal to the adoption of new production methods. A new building process was described in RATA2000 project. The basic idea was to:

- provide possibilities for better project management,
- allow more flexible organizational arrangements,
- redistribute responsibilities in order to motivate parties to individually develope new products and technologies; in particular producers of modules and components are given the responsibility of fabrication design without unnecessary limitations or instructions,
- open up possibilities for competition at various phases.

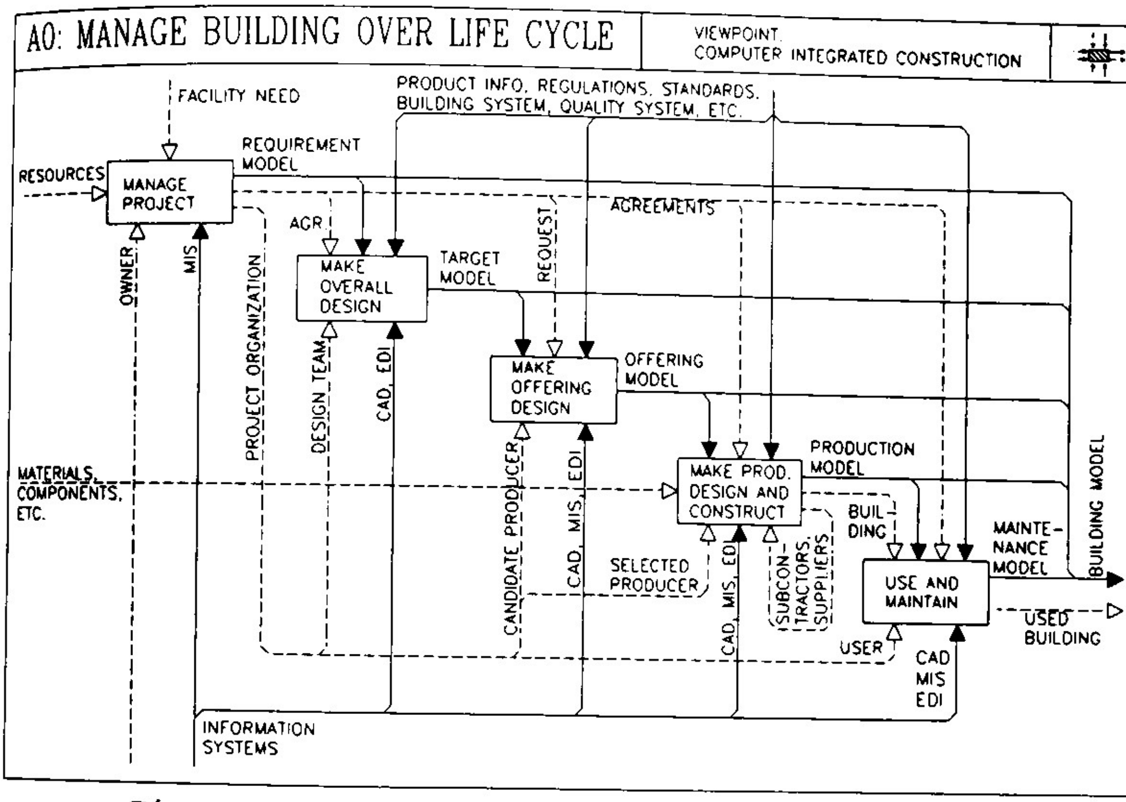

Figure 4: RATA2000 building process (idealized)

9. Conclusions

A common <u>product model for buildings</u> from the conceptual level down to the physical data exchange file specification level is needed in order that various computer systems can be integrated in the construction process.

Common <u>information modelling methodologies</u> should be widely adopted in order to overcome the barriers of mutual understanding between professionals in different organizations.

Successfull progress within CIC has been achieved by some <u>national efforts</u> in Finland due to a fruitful combination of several factors - the limited size of the nation being one of them. It has been possible to achieve consensus at a sufficiently broad basis. However, increased interaction with <u>international developments</u> is now reqognized as essential to assure the continuity of development in the long-term.

Industry not only needs <u>visions</u> about future but also practical solutions that provide a <u>step-by-step path</u> towards it. Commercial incentives to adopt new techniques and processes are weak in the initial utilization phase and need to be backed up by continuous long-term development activities.