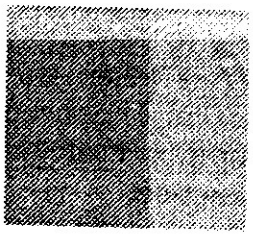
A 1 2

Hannu Penttilä
Raine Talonpoika
Sven Hult
Paavo Tiainen
Bo-Christer Björk



Technical Research Centre of Finland
Laboratory of Urban Planning and Building Design
Itätuulenkuja 11, SF-02100 Espoo, FINLAND
tel: +358-0-4561 fax: +358-0-4356 7011

RATAS BUILDING PRODUCT MODEL

EXPERIENCES WITH PROTOTYPES

Paper presented at the 2nd CIB W78 + W74 Seminar
Computer Integrated Construction
September 17th - 19th 1990 at AIJ in Tokyo, Japan*

ABSTRACT

Based on the framework provided by the Finnish RATAS -building product model, a number of demonstration prototypes of the model's structure and user interfaces have been produced and tested. The prototypes have been implemented in an MS/DOS -environment using a relational database and lately more efficiently in a Macintosh environment using hypermedia-, relational database- and CAD-software.

In addition to several smaller case studies, an existing health center has been modelled in the database from an energy consumption viewpoint. This model has been integrated with two different thermal simulation applications running on spreadsheet programs both in Mac and PC-micros.

The emphasis in the prototypes has been on a user-friendly interface to building representation data which is structured using an object-centered building product model.

---

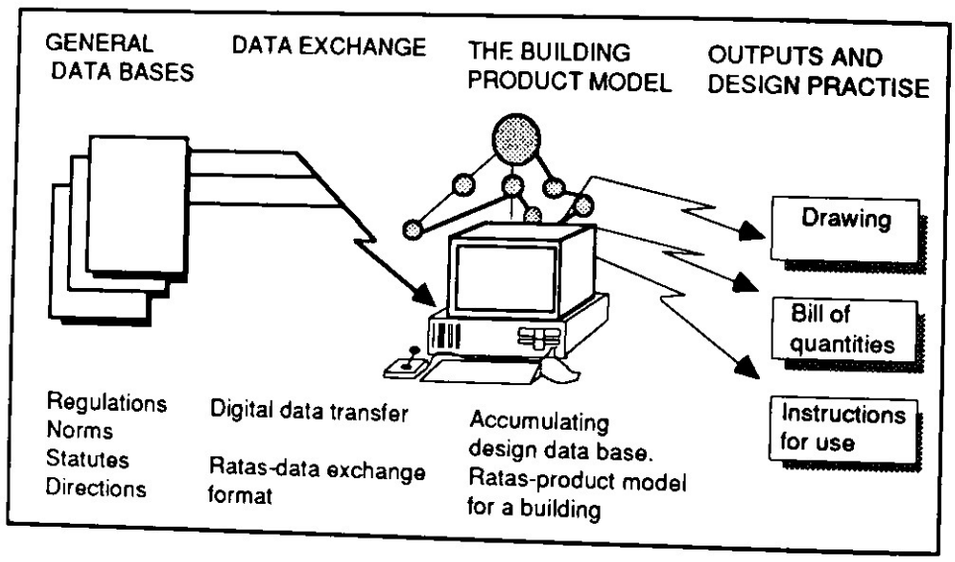
* This paper was also presented at the 2nd Finnish-French Colloquium for Information Technology in Construction June 14th - 15th 1990 - Tapiola, Finland

INTRODUCTION

RATAS-project

The background for building product modelling in Finland and in VTT lies in the late 80'ies when the RATAS -project created a national concensus about the future of computer integrated construction in Finnish practise.

A co-operative national study, RATAS II was carried out during 1987 with a budget of 3 million FIM. Some 50 persons representing widely the Finnish construction field were introduced to the problems of CIC data management. During 1990 the theory and problems recognized in phase II are tested in a more pragmatic phase RATAS III with a similar budget.



Overall view of the RATAS-project, phase II covered the chain from public general databases, digital data exchange into a building product model database and output documents of the future.

RATAS phase II created a framework for a conceptual building product model using an object-centered approach to information management./1/2/ The model structure has been applied to different purposes, such as CAD-systems for concrete structures, architecture and different construction field database applications.

/1/ Bo-Christer Björk: **Basic structure of a proposed building product model**, CAD-Journal, vol 21, nr 2, 3/1989, 71 - 78

/2/ Bo-Christer Björk: **An object-centered conceptual building model**, Preproceedings of the French-Finnish symposium on information technology in construction, CSTB, Sophia Antipolis, France 4.-5.10.1988, 12 p.

PRODUCT MODELLING AT VTT

theory and practice

VTT's Laboratory of Urban Planning and Building Design has since '87 actively refined and tested the RATAS model structure with a research team of half a dozen researchers and research assistants. The work carried out, has been both theoretical conceptual modelling and pragmatic prototyping. Our experiences have been, that these two together offer an effective research method, since practical dilemmas cannot always be solved without theory, and without practical implementations theoretical issues don't even exist.

prototype 1

The first product model study was programmed with the Oracle relational database in an MS/DOS environment./3/ The suitability of an object-centered conceptual building data structure was confirmed with the prototype. The need to separate the data from documents was also evident. The documents could even be user defined, such as room cards, component lists etc., as the SQL-based prototype proved.

020	Office room	Floor	Carpet floor is made of....
		Wall-1	Wall paper is fixed to.....
		Wall-2	Wall is painted with acrylic...
		Ceiling	Ceiing is of a pre-fab. metal...
021	Office room	Floor	Stone floor is fixed with...
		Wall	Wall surf. is painted with...
...	...	...	...

User defined component lists and other outputs produced with SQL query language in the first relational database prototype Here an example of a room query.

prototyping with Macintosh...

After this initial MS/DOS-prototype, several others have been developed in the Macintosh-environment, since it has been found quick and flexible especially in prototyping, when clear and pre-defined targets, not to talk about results, cannot always be predefined. Also the user friendly object-oriented character and pedagogical visual features of this micro have proven that the chosen environment is useful.

/3/ Björk,Penttilä, Saarinen, Moisio, Finne, Nervola: **A prototype building product model using a relational database,** ARECDAO'89 Conference, ITEC, Barcelona, April 89, 101-117

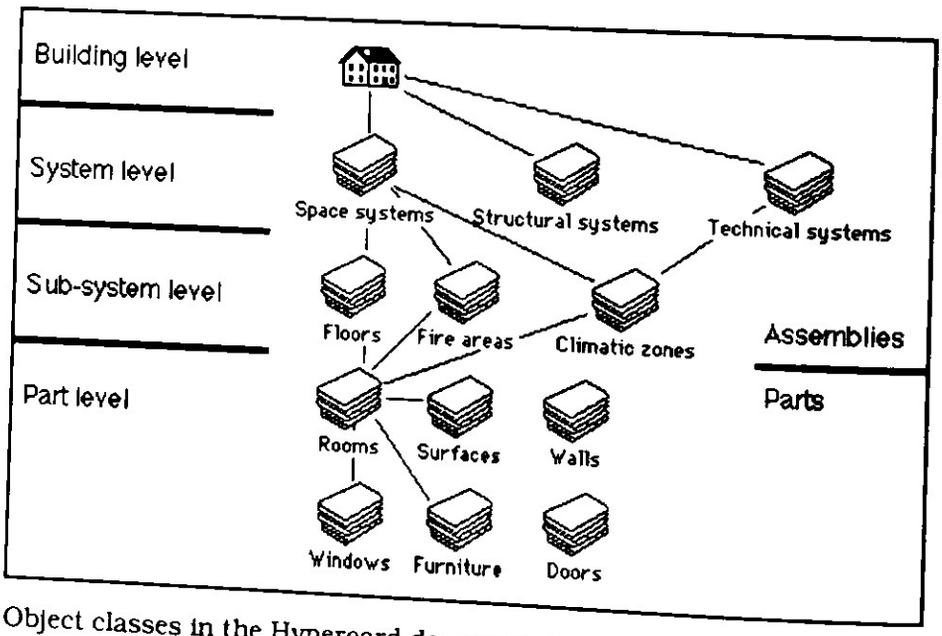
...has proven succesfull

The response from practise concerning Mac as a working tool, is naturally sometimes doubtful, and it should be. The construction field companies rely heavily on existing MS/DOS equipment, when talking about personal computing. We have however tried to emphasize that we have not been concentrating on practical applications or tools, but demonstrations and prototypes - kind of future sketches - to visualize the various possibilities existing in the building data management in the construction field.

building product model demonstration with Hypercard 2

The Hypercard-prototype is more a demonstration of the building product model structure, than a prototype. It is a user interface to the product model. It shows how:

- an object-centered approach has been implemented into building data
- hierarchies can be used for abstracting and generalizing building objects
- relations between objects create object hierarchies and network structures
- building object instances belong to general object classes



Object classes in the Hypercard demonstration.

The next step was relatively straightforward - to include a real database behind the object centered user interface.

prototype

3

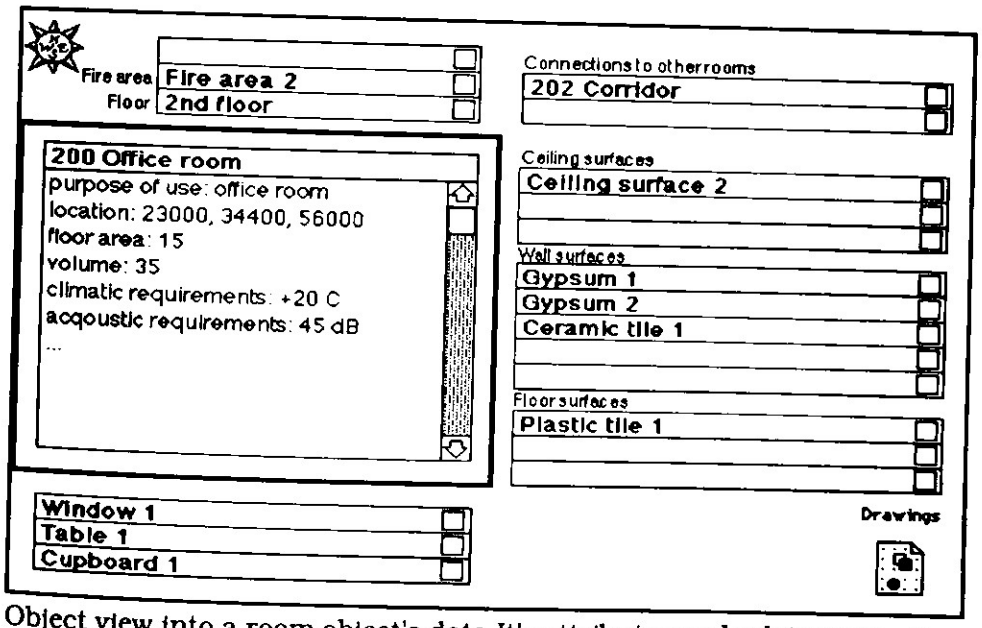
Oracle database with Supercard -interface

Supercard software was used to provide the interface into building object data in Mac's Oracle. Oracle was chosen, because the same database can in future prototypes be used in several hardware environments, MS/DOS, VAX, UNIX, etc.

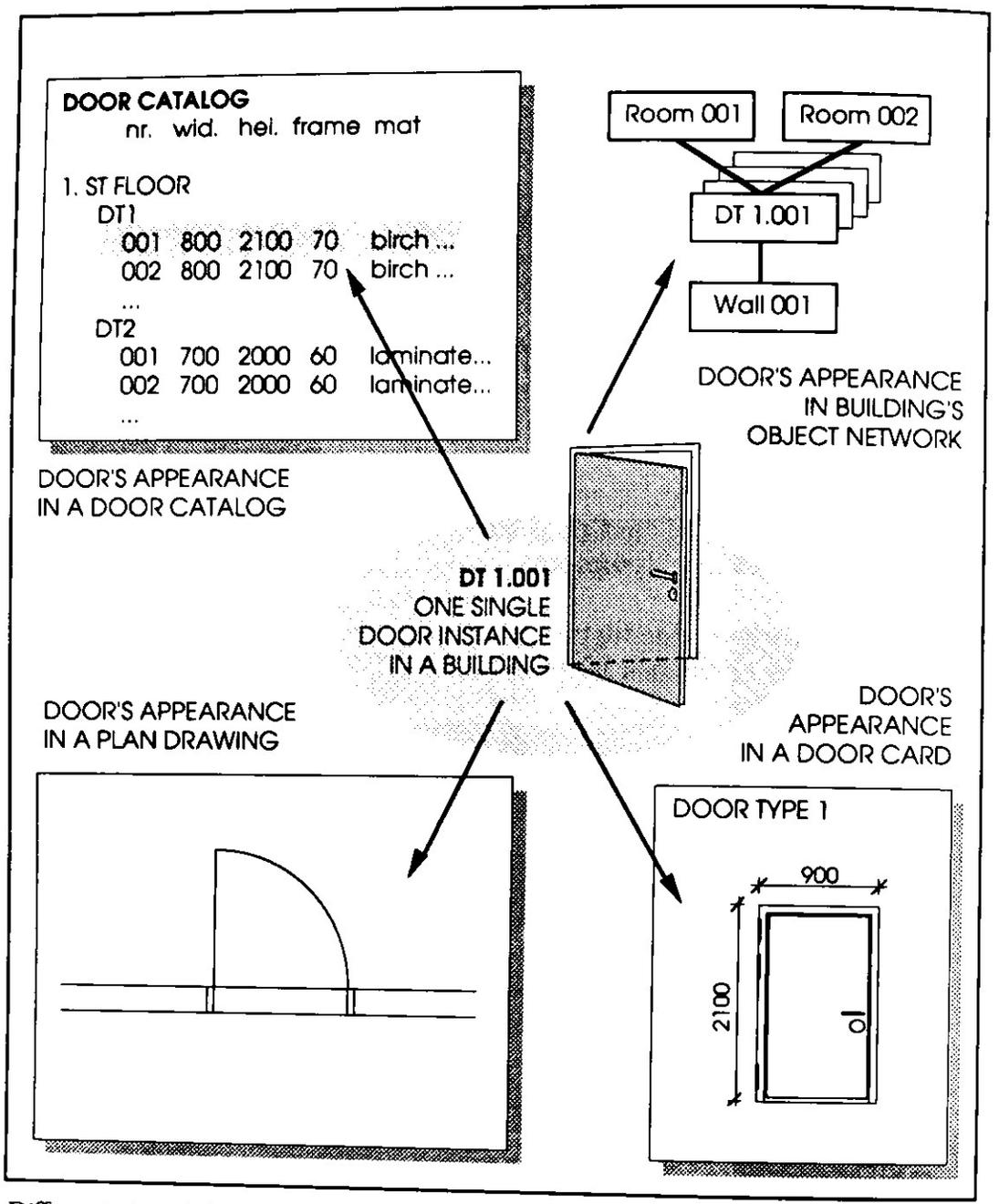
The prototype allows the user to view the core building object data from several different viewpoints:

- a common list-like catalog of all object classes, all object instances
- an object centered zoom into one object with all it's attributes and relations to other objects
- SQL facility - user defined queries to the database
- discipline specified output documents, a room-card, a door-card, etc.
- a graphic view to objects' geometrical attributes and reference graphics

queries offer flexible output possibilities



Object view into a room object's data.It's attributes and relations to other objects are seen.



Different views into a door's data in prototype 3. The data itself is in the relational database, and the interface allows multiple views into tho core data.

Oracle was used as a raw data storage media. All viewpoints to the data and tools needed to manipulate the data, were constructed with Supercard, which in fact appeared to be flexible in designing interfaces.

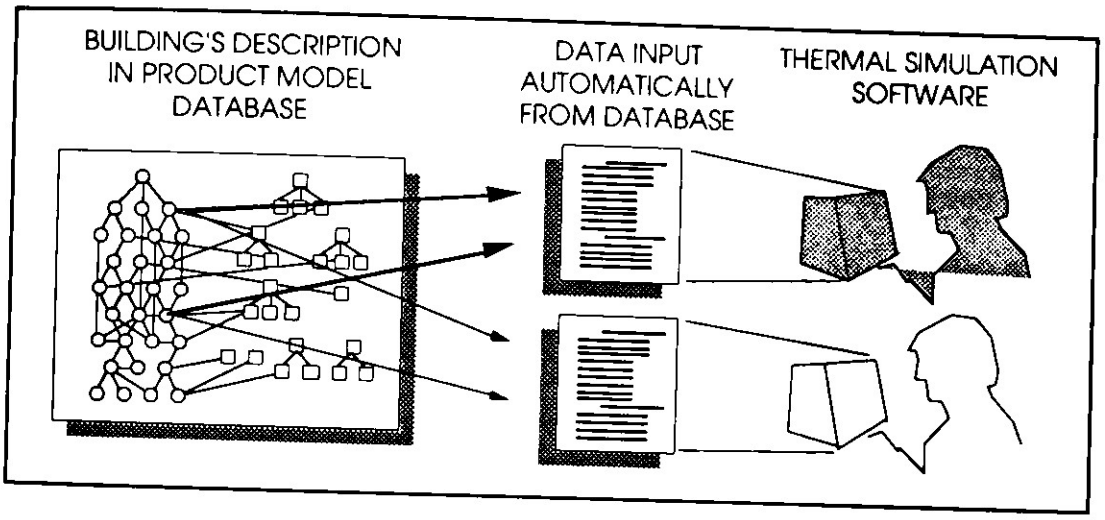
One major learning was, that relational databases are not suitable to handle data in object centered form, but the object appearances, relations, inheritance, etc. in the product model have to be described elsewhere - we did it in the interface.

testing prototype 3 with a case building

thermal simulation programs use the product model

The Oracle database prototype was tested in an application, where two different thermal simulation programs were connected to the building's product model database. A case building, Kontula health center, was modelled into the database. All attributes needed to thermally describe the building's outer envelope were included.

Two different thermal simulation programs were tested in this environment. D5 (based on Finnish regulations) running on Mac's Wings spreadsheet, and Mikrotase (commercial product, based on ASHRAY's BIN calculation method) running on MS/DOS PC. The input data the simulation programs needed were transferred automatically from the Oracle database.



Building product model used as a core database for two different thermal simulation applications.

Different thermal simulation applications use different input data, which has been one major border to use product model approach in, for instance thermal simulation. The lack of accepted building product models will also more generally resist the wide variety of possible applications.

Conclusions from this pilot were that direct data transfer between a product model database and thermal simulation programs could significantly improve the usability and reliability of thermal simulation applications. This research will be continued at VTT in the international co-operation project COMBINE, which is sponsored by the EC Joule R&D programme.

prototype
4

CAD-system as an interface to the database

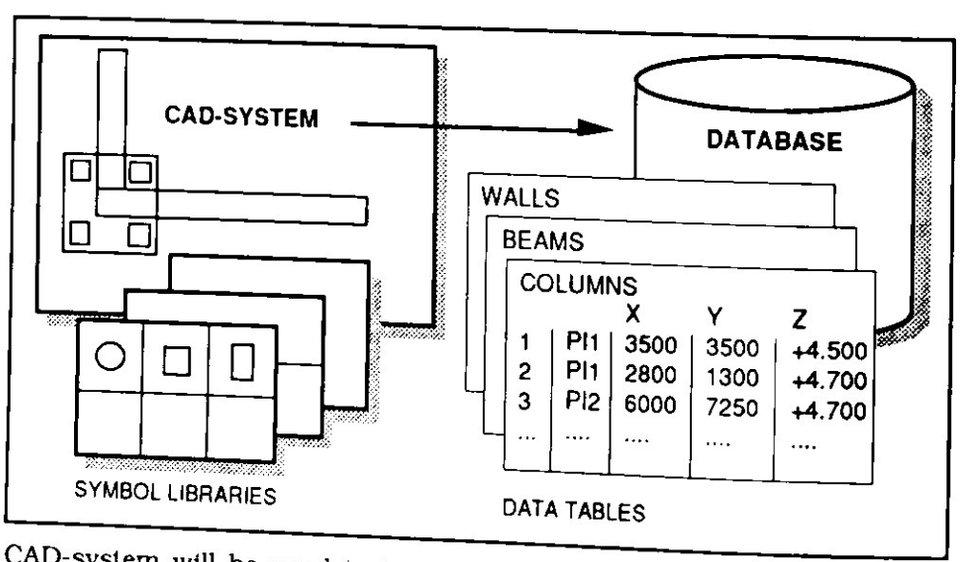
Data input to the product model databases had in the former prototypes to be done manually by keying alphanumerical data in, or using spreadsheets' copying facilities to fasten the input process. The intention though, had been that it should be relatively straightforward to create the database, for instance in Oracle, automatically. Since CAD-systems are designers basic graphical tools, the data input should be done with them.

Practical needs were pushing us to develop a more pragmatic product model prototype - an environment where a CAD-system is linked with a relational database. Intergraphs Microstation was chosen, because it already has built in links into the Oracle database.

The prototyping activity at the moment is organized as a RATAS III sub-project, and the product model is limited in the beginning to those objects' attributes that are important from the contractors' quantity take-off point of view.

The aim is to create the database (quantity attributes) with CAD and to produce bills of quantities, component list, element catalogues etc. from the database. The quantity takeoff is done several times during the design process, and it is a routine process, hence it should be done automatically.

bills of quantities are outputs from the product model



CAD-system will be used to input coordinate and shape data into the relational database in the next product model prototype.

conclusions

The conceptual building model used in the prototypes, has been developing during the practical tests. One long term objective, is to define a first version of a Finnish RATAS building product model standard, propably during 1991. The standard should contain the most essential building object classes (some 200-500 classes) with the most essential attributes (some 10-30 attributes per class). This draft should also include a description of the most essential discipline viewpoints and a scenario far how to move from current practice into a product model oriented data management./4/

a national building product model standard

SOME GUIDELINES FOR
THE RATAS - BUILDING PRODUCT MODEL STANDARD

- *A PRAGMATIC NOMENCLATURE TO USE IN THE FINNISH CONSTRUCTION FIELD APPLICATIONS*
- *WILL DEFINE*
  - *MAJOR BUILDING OBJECT CLASSES*
  - *MAJOR BUILDING OBJECT ATTRIBUTES*
- *COMPATIBLE WITH INTERNATIONAL STANDARDS (STEP/PDES)*
- *FIRST VERSION 1991*

the amount of building objects

The amount of data one typical building contains, is remarkably huge. Some very rough estimates vary from 50 000-200 000 building components, or objects each including a dozen of attributes. This totals up to 50-100 MB of data, just to have a scale. Understandably computing capacity of current hardware, both size and speed, has so far been one delimiter to use building size product models in real work, but since computing capacity develops constantly, this should not be a limit in the future.

/4/ Björk,Penttilä: **A scenario for the development and implementation of a building product model standard,** Adv. Eng. Software, 1989, vol 11, no 4, 176-187

A significant dilemma recognized in the work is the difference between ***the conceptual model*** and its ***applications*** with existing tools. It has been difficult to apply the somewhat ideal concepts into real environments. The relations between objects defined in the product model, for instance, have been modelled into a relational database with it's means, tables, rows and columns, although a relational database is not the most suitable tool to model these real life object networks.

the conceptual product model has to be developed into practical applications

One of the main tasks in the prototype projects at VTT, has been to prove that the object-centered method chosen for modelling building data can be implemented into existing hardware and software environments as commercial applications. The objective is to steer also commercial applications to develop into a more database oriented approach, as a contrast to the current document oriented practice and increasing use of CAD as a pure drafting tool.

object-centered method is suitable for construction field applications

It should be noticed that the object-centered building product model, which in fact is in the prototypes formed in the interface, is the most essential in the model. Just next to it is the raw data, stored for instance into a relational database. How the construction field concepts, building objects with their attributes, relations and viewpoints can be handled, finally validates the RATAS building product model.