C.I.B. seminar

THE COMPUTER INTEGRATED FUTURE

The minimal approach

Bauke de Vries
Eindhoven University of Technology
Faculty of Architecture and Building

16 - 17 september 1991
Eindhoven University of Technology

Abstract

A distinction is made between data-exchange within a system and between systems. For the latter a datamodel is defined with a clear limited domain called : the minimal model. Moreover a procedure is shown for exchanging data using the minimal model.

1. Introduction

Although productmodelling is a fairly new research topic, considerably work has already been done. In the Netherlands the BIM project has been the main national contribution. Apart from that, several independent developments take place in the area of coding, standardization and productmodelling.

Still most of the development is restricted to the research field. It seems that coding, standardization and productmodelling needs informatic specialists to be defined for usage in a computerized environment. On the other hand low level integration has been reached in common practice by choosing for example the DXF format of Autodesk for the exchange of drawing data.

There is a large gap between research and practice in which the top-down and bottom-up approach can be recognized. Yet the building community is asking for solutions for integration problems they encounter nowadays.

The question that is dealt with in this paper is : can a method be defined which supports today's state of the art in automation and does not withhold future developments in order to integrate CAD in the building proces.

2. Datamodel and data-exchange

In managing the data involved in the building proces, two different problems have to be solved :

1 Data produced within a system have to be structured so that concurrent usage by two or more modules of the system is possible along the productlifecycle.

2 Data exchanged at a certain time have to be structured so that usage of the same data within different systems is possible.

A clear difference has to be made between a datamodel to be used within a system (local model) or to be used between systems (exchange model). A system in this case can be regarded as a computer environment at a participant in the building proces.

Local model

Interactive usage of data
Optimized for applications
Historical registration
Concurrent usage of data
Depends on the environment

Exchange model

Data represent a certain stadium
Suited for common data
Data have a time stamp
Input for local usage
General usage by participants

Data models will be developed typically for every branch of the building industry, depending on the demands and financial possibilities. A data exchange model should solve the problem of communicating between such datamodels that vary highly in there purpose and capability.
Introducing a general purpose model for the building industry, to be used by all participants solves the communication problem, but has the following drawbacks :

- A general purpose model is never capable of maintaining all data involved the program-, design- and production-proces that is taking place at the participants in the building proces. So despite its meaning it will never be complete, because of the high complexity of the building as a product to be modelled.
- Imposing a detailed description of the building will frustrate future developments in building informatics.

All types of models define at the lowest level the entities to be used in applications. This implicates that in order to exchange data, mapping has to be done to these "neutral" entities. A more flexible approach is to define a data structure at meta level where the application entities fit in. In this way the relations are predefined but the entities reflect the applications. This method has the following advantages :

- no "new neutral" entities are introduced
- the participants are familiar with their "own" entities

3. Limiting the datamodel

When not trying to define a complete data model the question is what part of the building model should be defined.
Data that come forward during the design proces can be split into two groups :

1 data describing either
 the physical constitution of building elements
 the usage of rooms

2 data derived from group 1

The first group consists of only that information of a building design concerning objects that can be "touched". So for instance no calculating results as displacements, temperature, heat resistance are considered. By describing as closely as possible a building "as is", it must be possible to derive all other data from this information. This is true throughout the whole building proces.

4. The minimal model

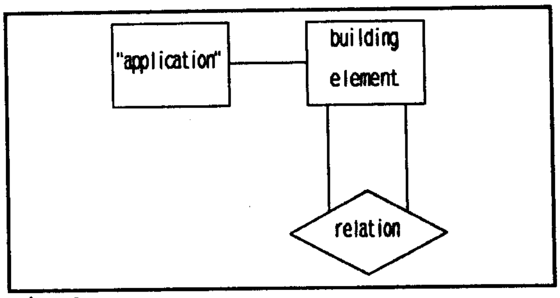


fig 1

Central object is the buildingelement. Each building element has one or more relations with other building elements. The application object offers the possibility to add information not available in the minimal model, always related to the building element (f.i. coding).

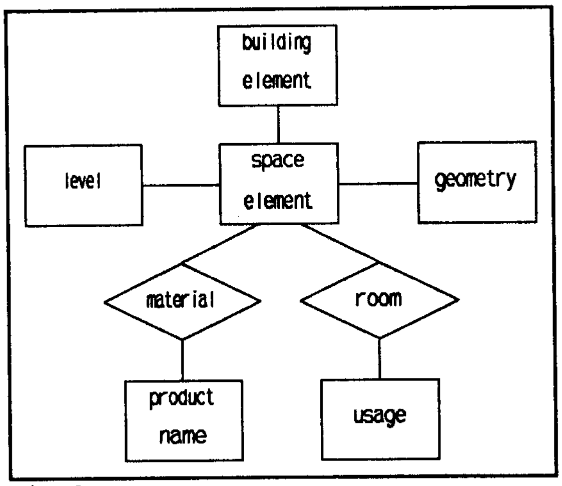


fig 2

A building element is uniquely identified by its name (f.i. kitchen-31, door-102) and refers to at most one space element. In the real world it takes a certain space quantity. This space can be filled either by material (f.i. brick) or by room (f.i. livingroom). The material is uniquely identified by a productname or number; the usage of room by human activity. Depending on the level of abstraction (f.i. building blocks, interior) each space element has a different appearance. Geometry is defined separately. Its description will change during the design proces and will probably not be present at all in the beginning.

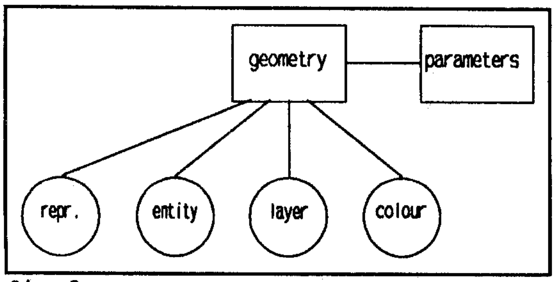


fig 3

Geometry description can take place in different representations (f.i. DXF, STEP-geometry, IGES). As long as no general standard has been reached, the sender and receiver have to come to an agreement about the representation format. Attributes that can be used independable from the representationformat are : layername and colour of the geometry. To support specializations of a general geometry object, parameter description can be used to reduce data. This too of course is strongly connected to the representation format.

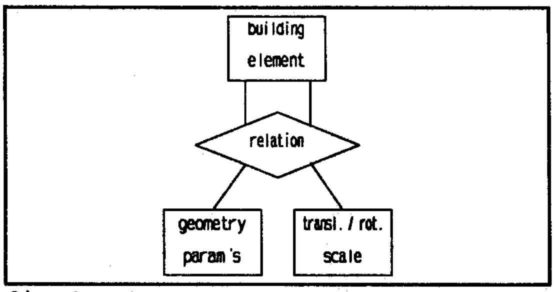


fig 4

Relations between building elements can be of different types. The geometry of one building element can be a specialization of a general one. To determine the location of a building element translation/rotation/scaling is needed related to this special building element called "the world". Remember : geometry description does not contain topological information.

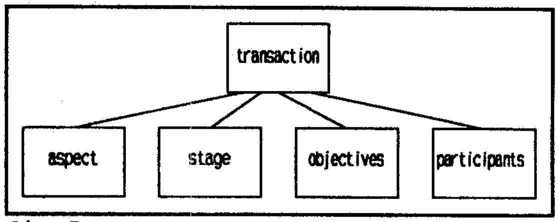


fig 5

Apart from modelling information of the building itself, the transactions that take place in the building proces between participants have to be modelled. A transaction can be characterized by the stage (f.i. preliminary design) , the aspect (f.i. construction) and the objectives of the participants (f.i. concrete calculations).

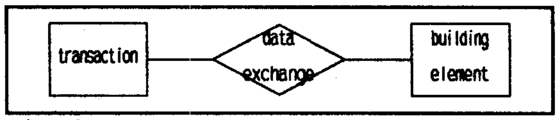
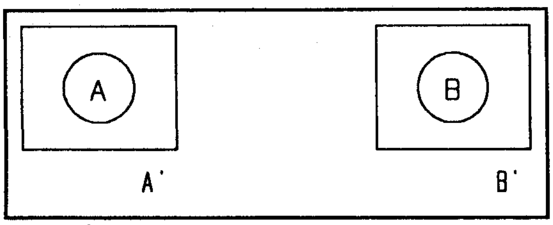


fig 6

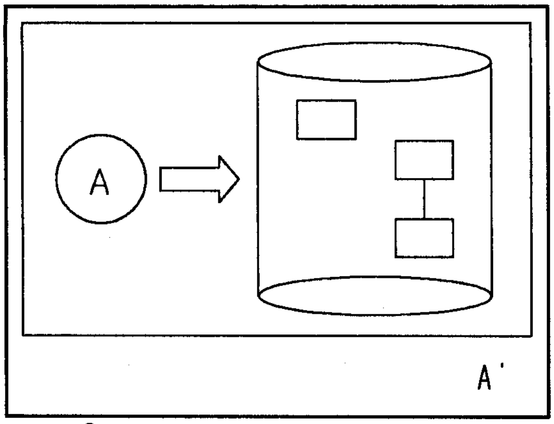
The data-exchange consists of a combination of the formal transaction and the building elements which it involves.

5. Data-exchange procedure



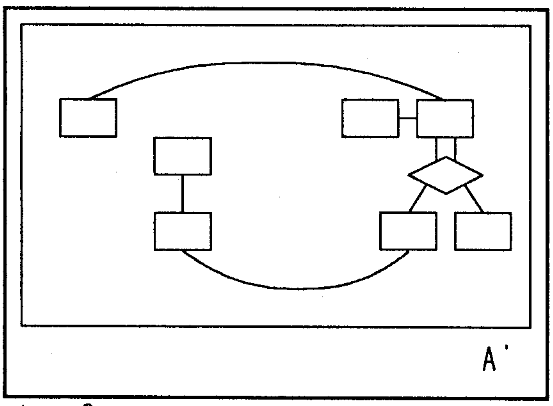
step 1

Participants : A' and B'.
Programs : A and B.



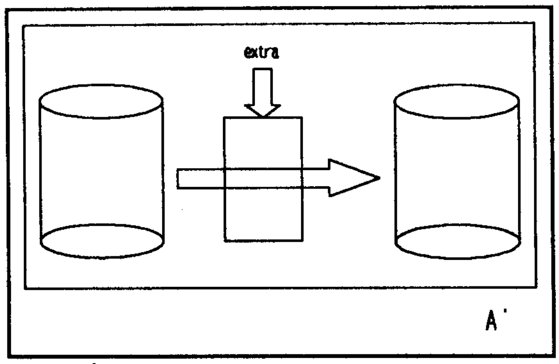
step 2

From program A a dataset (f.i. file) is produced with its own entities in accordance with the structure of the minimal model.



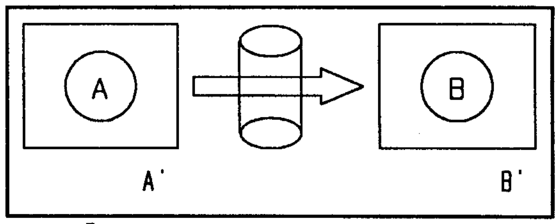
step 3

1 to 1 entity mapping is done by A'



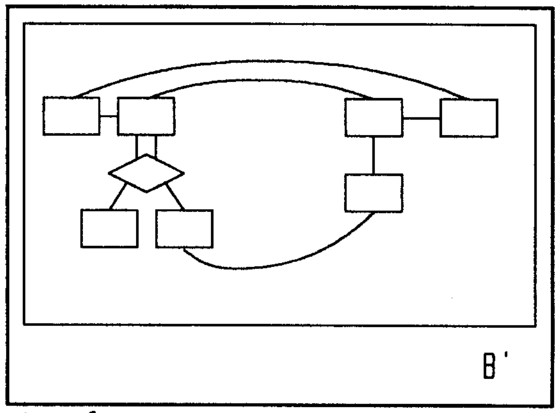
step 4

The information from step 3 is used for entity translation. Information reconfiguration and adding is done to get the full data-input for program B.



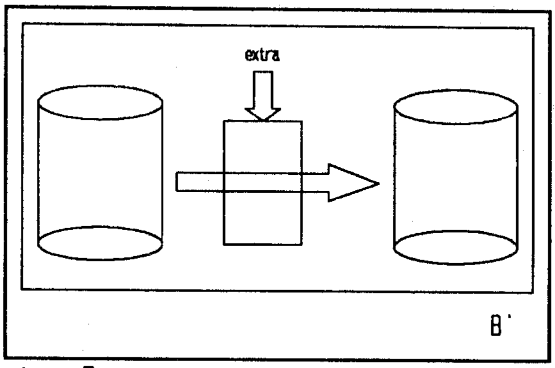
step 5

Data are sent from A' to B'.



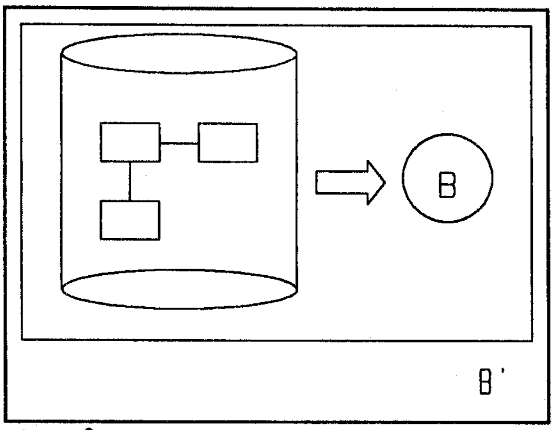
step 6

1 to 1 entity mapping is done by B'.



step 7

The information from step 6 is used for entity translation. Information reconfiguration and adding is done to get the full data-input for program B.



step 8

From the dataset (f.i. file) input is produced for program B.

Remarks :
The mapping algorithms in step 3 and 6 do not change as long as program A and B do not change their internal datastructure.
Step 4 and 7 are always a one-way translations, whereas step 3 and 6 can be used for datatransmission in both directions.
References (names, numbers) can be used for identifying material and geometry. When sender and receiver use the same libraries, references can be transferred instead of the complete descriptions.
With all applications, building elements must be abstracted to identify the objects. So just a line cannot be transferred; a meaning from the building environment must be attached to it.

6. Data-exchange evolution

In fact the data exchange takes place in two steps :

1. 1 to 1 mapping (cross reference)
2. transformation of data (unavoidable)

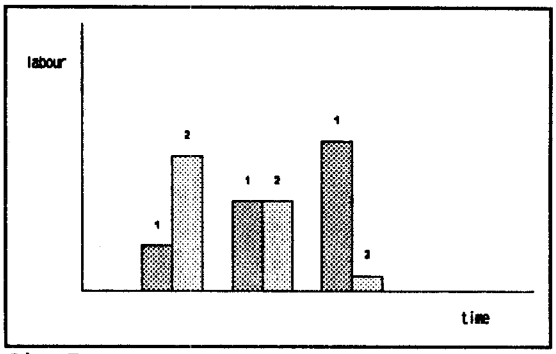


fig 7

In time when application's internal datastructure will support more closely the structure of the minimal model, less transformation of data will be necessary.

7. Why Classification and Coding

Arguments to classify data are :

- to resort data in order to group them by a certain characteristic
- to enhance search operations on certain data

Arguments to code data are :

- same as for classification
- codes are shortterms for a certain amounts of information which are easier to handle

When using the minimal model, data are already structured. The entities reflect the participant's building environment. Grouping and search operations can be operated by any Data Base Management System using the datastructure and the entity- and attributenames. Only the shortterm option stays relevant in a new way. Data reduction is received when both participants use the same coding for f.i. geometry and material (= the same software libraries).

8. Research and Development

Electronic Data Interchange developments are at the moment primarily focussed on pure administration. But since their is no clear distinction between information enclosed in papers and in drawings, EDI seems to be the first step in the area of data exchange between computer systems. Proces modelling techniques and data modelling techniques used for defining messages in EDI may well be extended for use in Product Data Interchange.

Therefore a case-study will be defined based on material from building practice. First an informal description is made of the programming-, design- and production proces for a small office building and the data that are involved.
Then a formal specification method developed at the department of Mathematics and Computing called ExPect will be used to model the proces. In the procesmodel, datamodels reflecting the data that are dealt with will be integrated.

At the same time concurrent activities as the STEP development will be investigated to see if integration of the proposed minimal model and data-exchange procedure is possible.

9. References

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