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CONCEPTUAL MODELLING OF BUILDING

MODELLING THE PRAGMATIC SOLUTION

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KEYWORDS

Building modelling. Architectural knowledge. CAAD.

ABSTRACT

An architectural project, designed with a modelling system was followed closely from sketching to detailed design, a report was made.
Experiencies on the use of a system with an architectural vocabularium and architectural operations will be presented.
The presentation will concentrate on how building modelling is facilitated by the system's understanding of building and building parts, and the way they are built together to form rooms, and on facilities to represent details without modelling in full detail as a short cut in modelling.
The pragmatic solution to the problem of CAAD-systems with architectural knowledge is discussed in terms of current limitations and further extensions.

Introduction

A pilot project supported by the Ministry of Industry with the goal of investigating the possibilities and the problems which practising architects have to face when an integrated CAAD system is used as a modelling tool in all phases in a building design process has run from March, 1987 to March, 1988.

In the pilot project the design of a building, with the use of the CAAD system GABLE 4D Series, was followed closely and the design process was described in details in the report: ARKITEKT-PROJEKTERING MED EDB-VÆRKTØJET of which only the first chapter, where results and background are resumed, so far has been translated into English.

The building, a Centre for Elderly People in Aarhus, of totally 9,900 square metres has about 80 dwellings and a 2,000 square metres service centre. It was designed by the architects, Arkitektgruppen i Aarhus A/S. The Datacentre for Practising Architects, School of Architecture in Aarhus was responsible for the report.

GABLE 4D Series running on VAX and TEKTRONIX equipment were elected as design tool in the pilot project, as it was capable of supporting the whole design process with 3D modelling tools, and architectural knowledge built into the system to facilitate its use.

The following is a description and evaluation on some of these facilities and their use in practice. The intention is not to cover fully the ideas of incooporating architectural operations and vocabularium into CAAD systems, but just to draw attention to some ideas. Hoping to add to the understanding of knowledge-based Computer Aided Architectural Design.

Architectural elements

Building modelling with GABLE 4D Series is based on a catalogue of "intelligent" constructions and elements, defined with their specification and geometry and located in the building model.

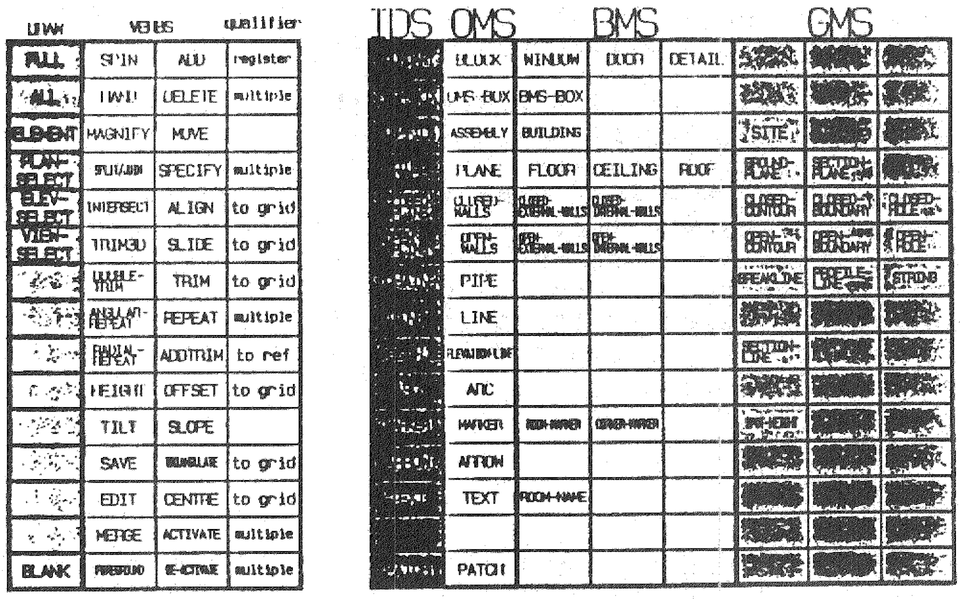


Fig. 1 Menu with verbs and nouns

Constructions: External and internal walls, floor, ceiling and roof are specified and geometrically defined with material and thickness of each layer in the construction.

Components: Windows, doors, and details is specified and geometrically defined with their materials and dimensions. Graphics, plan, section, and elevations are attached to the components.

Modelling, the location and dimensioning of architectural elements in the building is executed by basic commands consisting of a verb: ADD, MOVE, DELETE, SPECIFY etc. and a noun, element types: WINDOW, EXTERNAL, WALL etc. All commands are working on plan and many on elevations and views.

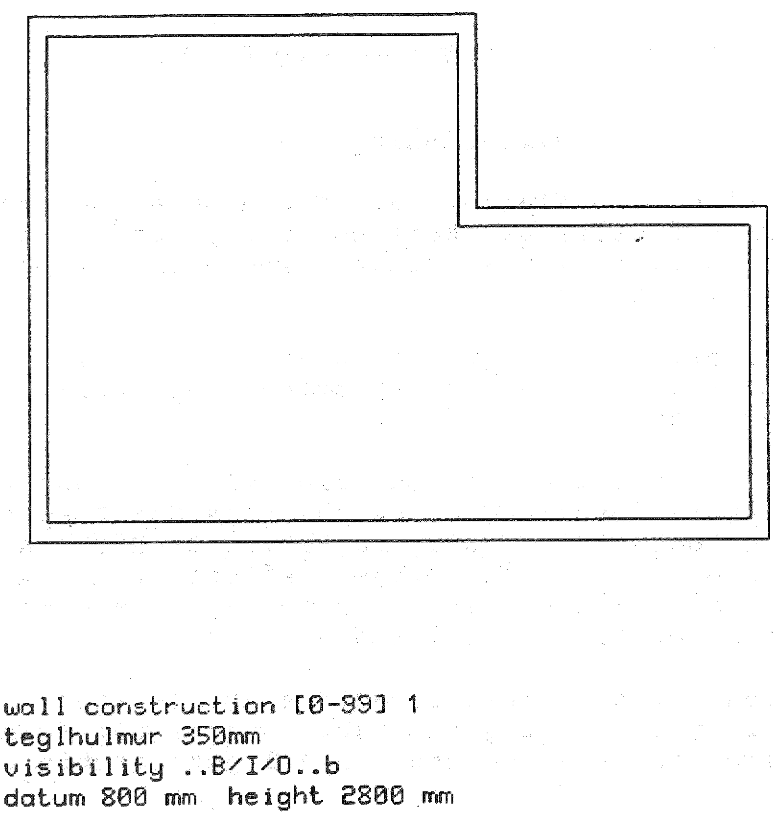
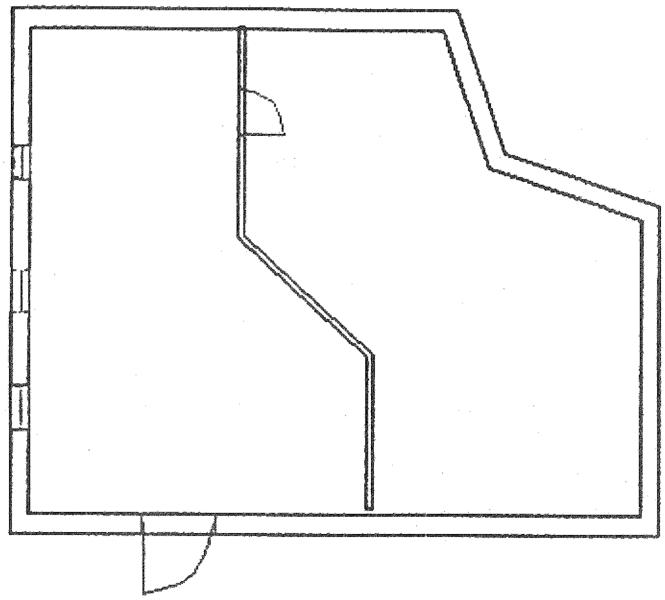


Fig. 2. Screen picture: Modelling a wall on plan view.

To model a wall the left or right side is drawn, whereas the thickness is derived from the catalogue, and height and colour code is typed in.

Components are selected from the catalogue and windows and doors automatically line up to the walls in the insert point. The height is typed in if the component is located in plan view.



BMS 1:100 a90 deg ht 2000 mm vt 2000 mm snapOFF PLAN
FULL

Fig. 3. Screen picture: Dimensioning the plan

The "intelligence" of the elements are shown when the contours, corners and joints of walls are kept correctly, and windows are kept in the walls during plan sketching, where the elements are dimensioned and moved around.

Also if a specification, e.g. the thickness of a wall is changed in the catalogue, the changes are reflected graphically in the model in a correct way.

These "low level" knowledge-based building elements and the architectural operators described below make the GABLE system a true 3D sketching tool, not totally replacing traditional sketching, but as found in the pilot project efficient and useful in an interaction with it. Ideas sketched on paper were modelled right on to form a correct control and notation.

Further development of the "intelligent" elements should investigate the possibility of letting the user control build in knowledge and allowance for user defined intelligent architectural elements.

Architectural operations

As the floor levels in the building are modelled one by one and stored, the ceiling and floor construction type and heights are specified.

```
interpret BUILDING file(s)

enter name of file or building model agger
Range of levels in building model -
start of range or B for whole building model 1
end of range (or press RETURN for single level)
specify tolerances for ISAAC in millimetres
[default values normally enough if aligned]
corners.....[ 0]  35
abutments...[ 0]  35
What pens and colours do you want to use for the
floor and ceiling planes to be created by ISAAC?
floor pen [1]
floor colour [0]
ceiling pen [1]
ceiling colour [0]
associated assembly files may be included in the
interpreted file as subfiles
do you want this..Y/N.. [Y]
tracing file
initialising ISAAC
loading walls
 9
calculating wall equations
analysing wall abutments
analysing wall ends
creating space outlines
 2
space outline wall thickness
 2
locating space outlines
locating obst
```

Fig 4. Interpretation module

A full 3D model can then be created. This is done by an automtic interpretation module known as ISAAC (Interior Space Assembly And Contents). In the process of interpretation ceiling and floor plans are added to each room in the building model, and walls are joined correctly within a specified tolerance, thus allowing minor inaccurancy in the modelling of wall elements.

The interpretor also assembles all the floor levels into one model and extract a surface model of each room and the exterior with components assigned to the walls. These surface models, small as they are, can be used for effective rendering, but should not be used for modelling as they are separated from the central building model.

Interpretation with automatic completion of the building model is a facility that makes modelling much easier, although the analyses are made in a programme module separated from the layout module.

In future versions of the system, interpretation will be an instant action, and there are plans for a new element type: ROOM, to facilitate sketching further. Modelling with rooms is just sketching the form of the rooms, whereas the constructions and components are added more or less automatically as a result of knowledge-based instant interpretation of the design.

```
current stairs information:-
no. of steps = 13
pitch (degs) = 42
going(mm)     = 239.21
rise(mm)      = 215.38
floor-to-floor height(mm) = 2800
overall length(mm)        = 3109.72
length except last tread  = 2870.51


which do you want to change

 1...number of steps
 2...rise
 3...going
 4...overall length
 5...overall floor-to floor height
 6...type of building

 0...exit

 enter choice 0-6
```

Fig. 5. Stair module

The system contains a stair moule where stairs can be modelled automatically as a result of parametre specification.

This operator is an efficient way of creating a complex submodel, and systems should allow users an easy way to define new knowledge-based achitectural operators.

Architectural details

The last topic is the production of drawings as a result of the creation and refining of the building model.

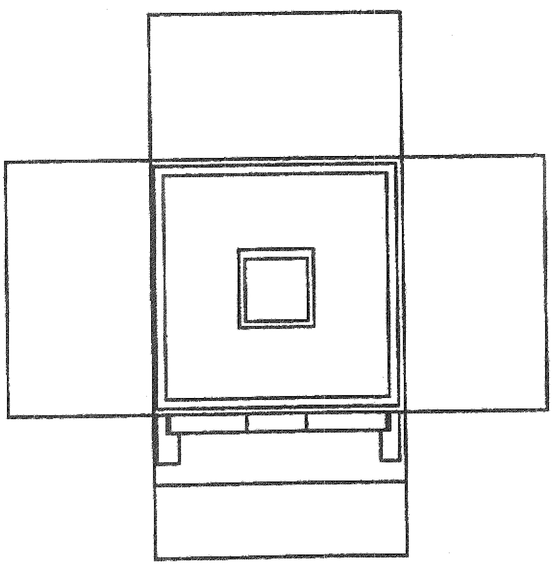


Fig. 6. Graphics attached to a window component

The way details are added to and extracted from the model is similar to traditional design documentation, where typical cross sections form a sufficient but not complete description of the design.

In GABLE 4D Series details showing how elements are joint can be attached to components as 2D graphical images.

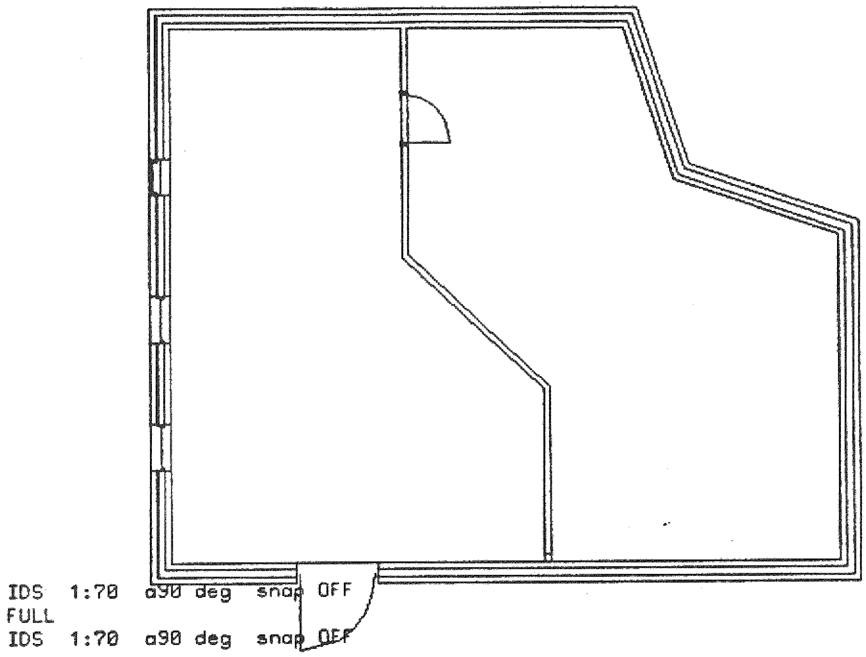


Fig. 7. Detailled plan drawing

Extraction of detailled 2D drawings: plan, sections and elevations from the model is an automatic process by the programme module MIDAS.

On detailled drawings all layers in constructions may be shown, together with the graphical images of the components. This technique produces reltively complete working drawings, with only litte need fr supplements and therefore securing the consistency in the procject, as documents are derived directly from the model.

The results are best in plan drawings, as wall and window detailing are well developed. Sections cannot be extracted with quite the same quality and therefore has to be corrected and added to.

Further development of knowledge-based modelling techniques will allow for efficient complete and detailled building modelling.

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