CONCEPTUAL MODELLING OF BUILDINGS
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PROPERTIES OF FUTURE BUILDING HYPER DOCUMENTS

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ABSTRACT

The paper describes and exemplifies how modern information technology may impact the properties of future computerized building documents and models. It is now possible to practically handle large quantities of data in the form of color pictures, film, sound recordings, animation sequences, drawings etc. The systems we formulate today are better suited to capture information putting higher pressure on the users concerning formulation of demands on user interface, model descriptions and model building tools.

A group of projects under the label KBS-MEDIA, knowledgebased systems - media, are aiming at integrating advanced software (knowledgebased systems, Hyper Card from Apple computer, etc) with new distribution and storage media. The hyper documents which are created possess powerful man-machine interface and dynamic model building properties.

The system forms a demonstrator environment used in different applications to capture, test and communicate ideas and admitting fast prototyping. New tools are defined, developed and tested. Tools which support conceptual modelling activities, use and building of hyper documents in a multimedia environment. The following building applications are at the moment included in the research: The City Advisor, Window Renovation Advisor, Advanced Information Technology in Building Maintenance Support (the Delphi project) and Advanced Material and Vendor Information, (the AMVI project)

1. INTRODUCTION

On the scene now we have a set of very powerful tools which have come out from the laboratories, tools which are now practically usable (object oriented systems, induction systems, production systems, hybrid AI systems, neural networks, optical storage media etc). Higher demands are put on organizations and individuals to try to formulate requirements on how to best use the new tools. Work content, organizations interrelations, product (from idea to demolishment) and information technology will all be changed under mutual influence. Hopefully we will get higher quality in what we produce and in the way we produce it.

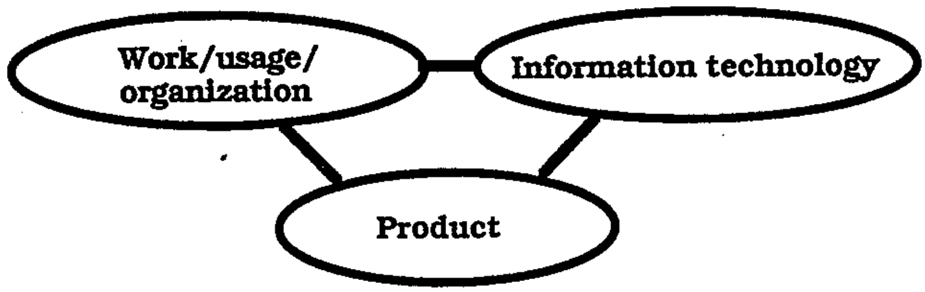

Figure 1. Evolution under mutual influence.

We can put the same question as we have done as long as computers have been around, namely: How can information technology, IT, help us make better buildings? Some parts of the building process ought to benefit especially from the new tools: teamwork in early design and sketching, consideration of client demands, improved tools and data for operation and maintenance of the product (building).

We must be aware of the risk that knowledge may be built into the systems knowledge that ought to be left out for human treatment. We must also not force development but carefully analyze improvements. This can be facilitated by using demonstrators to capture, test and communicate ideas.

2. MODELS, DOCUMENTS AND MEDIA.

It has been mentioned elsewhere, /1/, that it is increasingly important to treat not only knowledge about the building process and product but also knowledge about the characteristics of the computerized tools. It is of course not always possible to draw sharp boarder lines between the three domains. Modern information technology let us design tools that have properties which adapt to different users needs and also behave in a similar way independent of application.

According to the dictionary a *medium* is
- an intervening substance through which something is transmitted or carried on
- an agency by means of which something is accomplished, conveyed, or transferred

A *document* is traditionally considered as a static message. It is used to deliver a message and preserve it for later use or reference.

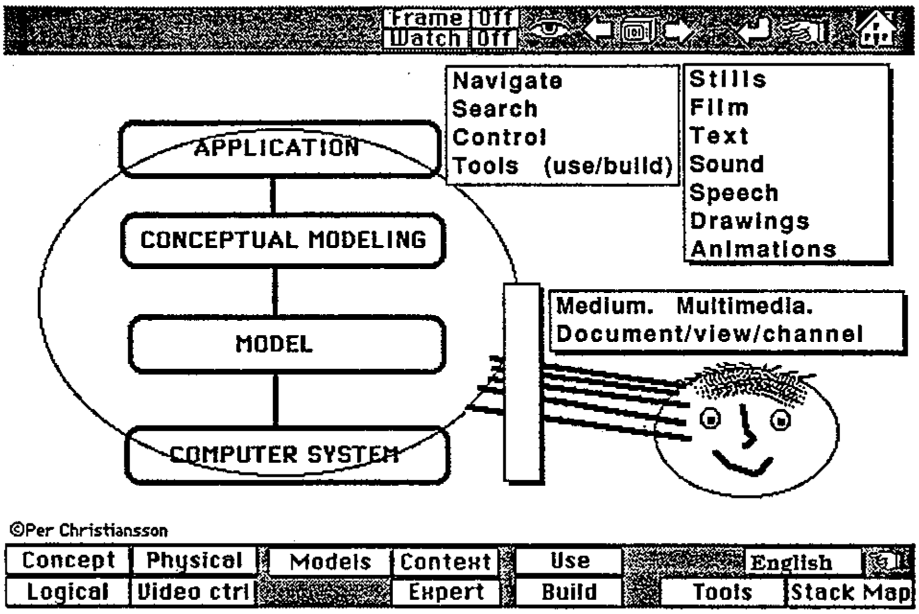

Figure 2. Conceptual modelling, model and document

Todays document can be given new properties, it is no longer static and might even be regarded as a "living "representation of a part of our reality (an object, a process, a method etc.). The document has got a new dimension and cannot clearly be distinguished from other representations/reproduction of reality, which we can call *models* of reality.

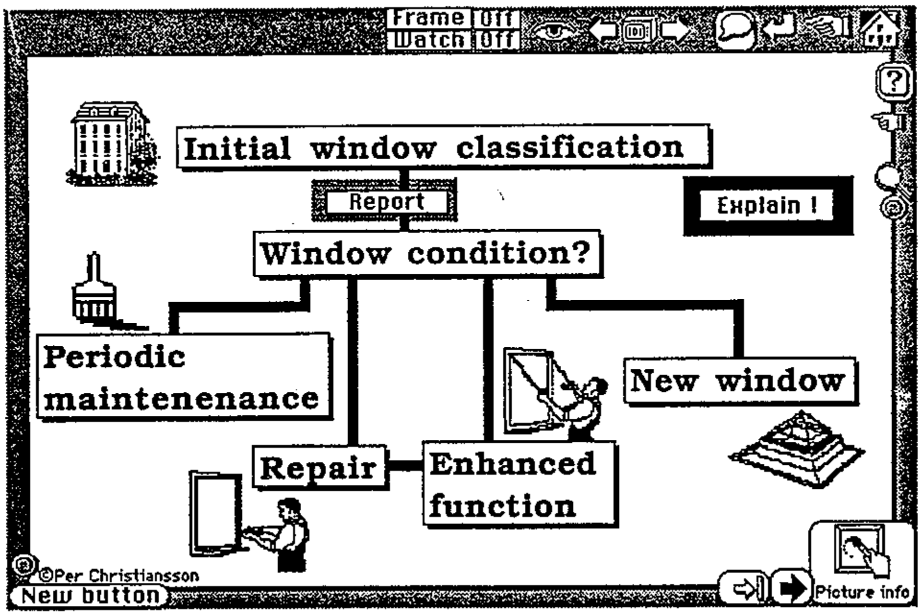

Figure 3. The top conceptual level of the Window advisor hyper document.

The paper medium was given new properties when the spreadsheet was invented. Text can now be written in the form of hypertext, /2/, and now we can use a new invention/tool with the name HyperCard (from Apple Computer) to very freely express our intentions. See also /3/ regarding 'inventing the future'.

Perhaps we could talk about *hyper documents*, at least for a while, to summarize something having the properties of model, document and medium (for transfer/publication and storage).

Starting from a conceptual scheme as that in figure 3 a user can navigate in a model supported by color images to gradually built up a context which classifies a window under consideration. In the same way another context is filled with description of the window condition. Finally with the help of these descriptions the user will get advice from an integrated 'expert' on proper steps for renovating the window. The user traverses and uses the advisor in a non-sequential way. Context is filled in and refined during use of the different parts of the hyper document.

3. THE KBS-MEDIA ENVIRONMENT

Since the autumn 1987 the work on building a KBS-MEDIA environment has been carried through at the department of Structural Engineering in Lund. Today we will experience some of the properties of the system. (KBS=knowledgebased systems).

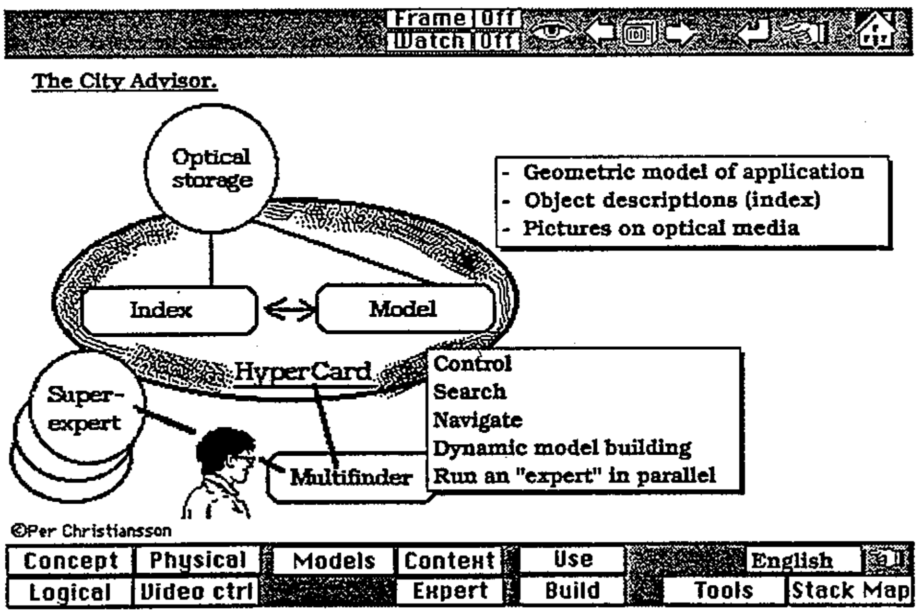

Figure 4. The KBS-MEDIA environment (example from the City Advisor). HyperCard, SuperExpert (knowledgebased systems) and optical media are integrated. (Multifinder is the operating system of MacII from Apple Computer).

The most powerful features of the KBS-MEDIA environment are

* computerized models supported by *real life pictures* and *sound*
* *integration of advanced software* tools as hypercard and knowledgebased systems

* *integration of optical storage media* to support different computer stored models (the same optical disc can support different models)
* offer of *generic tools for problem solving* (decision support, information browsing and search) and design of *man/machine interface*
* clearer and more obvious connection between *application* and the computer stored *model*
* powerful tool for *knowledge transfer* (training, education)
* *fast* and simple *prototyping*, powerful modelling tools
* simplified *knowledge elicitation* and *dynamic* growth, change and validation of models
* *Demonstrator* for capture, test and transfer of ideas

Film sequences with sound and pictures are stored on a analogue videodisc (54.000 frames). Pictures are also stored digitally on hard disc or CD-ROM. In the latter case the number of stored color pictures will decrease to approximately 1-5000. The optical storage media possess different qualities which influence which one(s) should be chosen for a certain application. (1) Type of information (stills, film, sound,...), (2) size of edition, (3) validity in time for stored information, (4) multi usage of the disc (many applications), (4) how will information be maintained, (5) how do we collect and transfer information to the optical medium.

4. SOFTWARE AND HARDWARE

Part of the hardware used is sketched in figure 5. Also a portable PC/AT (Toshiba) is available to ease work outside the laboratory when information is collected (partly through use of induction systems, learning by example, see /3/).

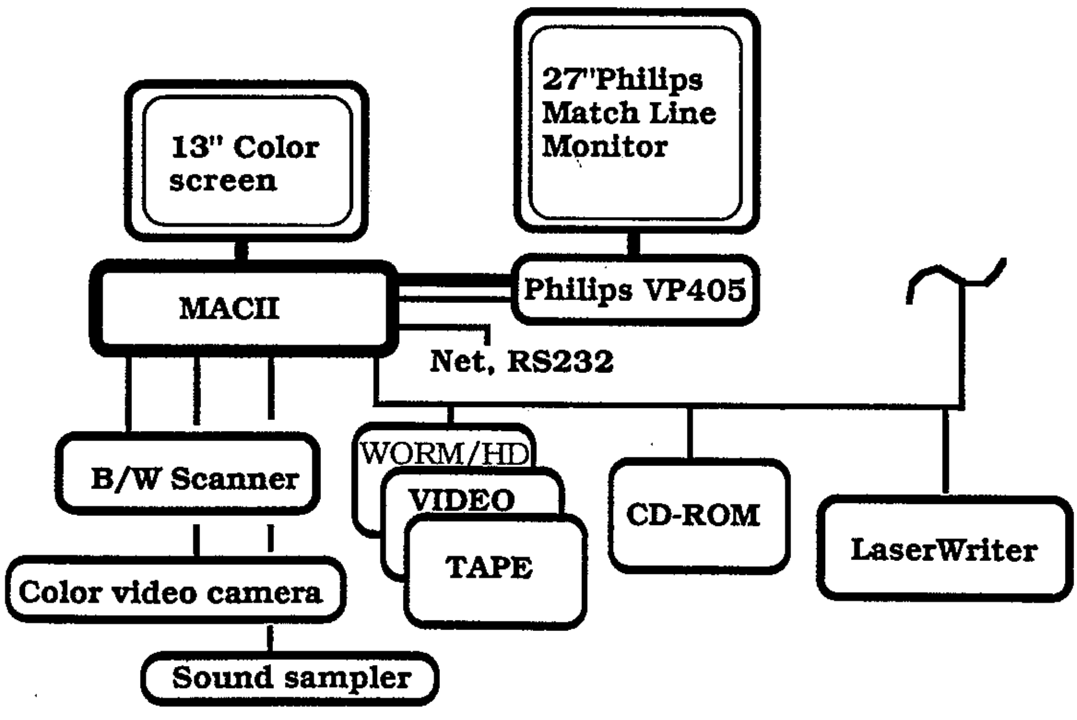

Figure 5. Physical units in the KBS-MEDIA projects.

The HyperCard program from Apple Computer is not a classical object-oriented programming system. *Messages* are passed between *objects* and handled by *scripts* residing in the objects. The scripts are written in a language called HyperTalk, which makes it very easy to understand what a script actually does when a message is received.

The objects in HyperCard are of three kinds. In hierarchical order: *buttons* and (text)*fields*, on the same level, residing on *cards* with common *background*. Cards are belonging to *stacks* together with the necessary *home stack* and finally on the highest level *HyperCard* itself. HyperCard stacks are both documents (data) and applications (programs).

With help of HyperTalk scripts and so called XCMD (external commands) and XFCN (external functions) the user has got a very powerful set of tools. For example within the KBS-MEDIA project a new command has been implemented which uses a XCMD (written in Pascal) to receive messages from an external videodisc player.

The relative easiness by which systems based on HyperCard can be filled with information emphasizes the need of a solid conceptual modelling work (objects, relations, naming, descriptions, control structures etc.)

5. CONCEPTUAL MODELLING OF THE APPLICATION. MODELLING TOOLS.

The basic software tools shortly described above support the conceptual modelling activities and also in shaping meta tools (tools to make tools). The end user needs tools when he/she is modelling and using/building the computer stored model of the application. The old programmer has become a tool maker.

The actual (a) definition of *problems* and sub-problems are very much a manual work which though may be supported by for example systems that are 'programmed' by given examples, see /3/. As (b) problem *solutions* are defined on a top level, (c) knowledge *representation*(s) (mixed) and (d) *search strategies* can be defined providing an environment for (d) *dynamic building* of hyper documents. The steps will be repeated as work progresses.

It is of course extremely important to define the model building tools as well as possible in the beginning of the process. If you for example create an application specific tool for making references to film or picture on an external optical disc unit, it is very favorable not to have to change the script (at a late stage) of all references created (e.g. buttons in HyperCard) due to bad planning of development directions.

Figure 6 shows a palette by which the user/builder can browse ('sweep') among pictures on a videodisc, click on the palette to 'pick' up a picture and navigate to that part of the hyper document where a reference is to be placed. Then use a 'new button'-tool to create a new script and button by which the picture later is called up. This process is valid for automatic creation of application specific links to film, sound, procedures etc.

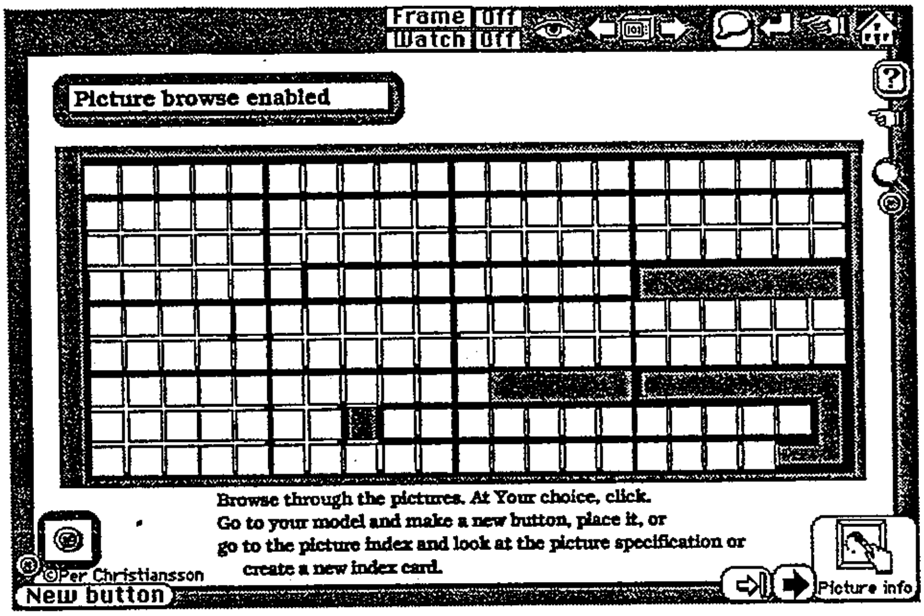

Figure 6. A palette for browsing and 'picking'references to videodisc images. Tools for creating the palette are found in the lower left corner.

The HyperCard system is well suited for the modelling activities. The object orientation has built in advantages. The systems will for example warn you when a message cannot be handled. Resources as sampled sound/speech are easily incorporated into the system.

6. USING AND BUILDING HYPER DOCUMENTS

Below some comments are given on how a hyper document might be used and also expanded by users knowledgeable about the application. Figure 7 shows the main entrance to the City Advisor. The'MAP'- and 'Halmstad object index'-buttons transfer control to stacks containing

- the geometric model '*MAP*' of the city (scanned maps, drawings, etc.) and
- the '*Halmstad object index*' with descriptions of city objects linked with pictures on videodisc.

In figure 7 we can also find

- *Select mode* - navigate or learn. In learning mode the building tools are available and made visible. That is access levels which depend on user knowledge.
- Entrance to the '*experts*'. To call up an expert and to jump back to the expert
- Tools to *search* the 'MAP' for an object which was found during picture browse on the videodisc (flashing arrow on the map when found)
  to *search* the 'MAP' for an object found in the 'object index' stack (flash)
  to *search* in the object index for specified text occurrences (proper object card will be displayed).

Generally the hyper documents allows us to navigate and search along many paths through different channels (text, graphics etc.).

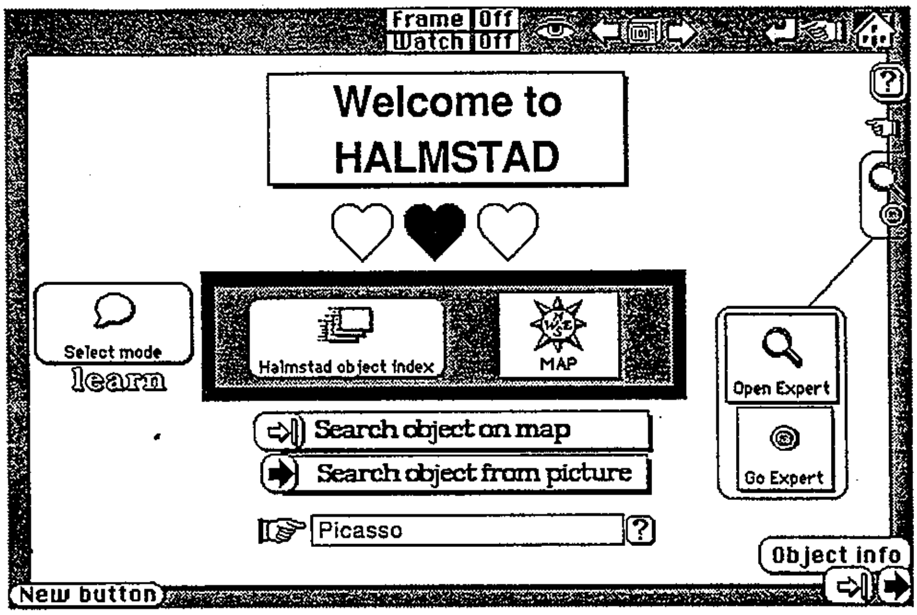

Figure 7. The main entrance to the City advisor hyper document

Below short comments are given on how to *use*-and *build* (*expand*) the hyper document:

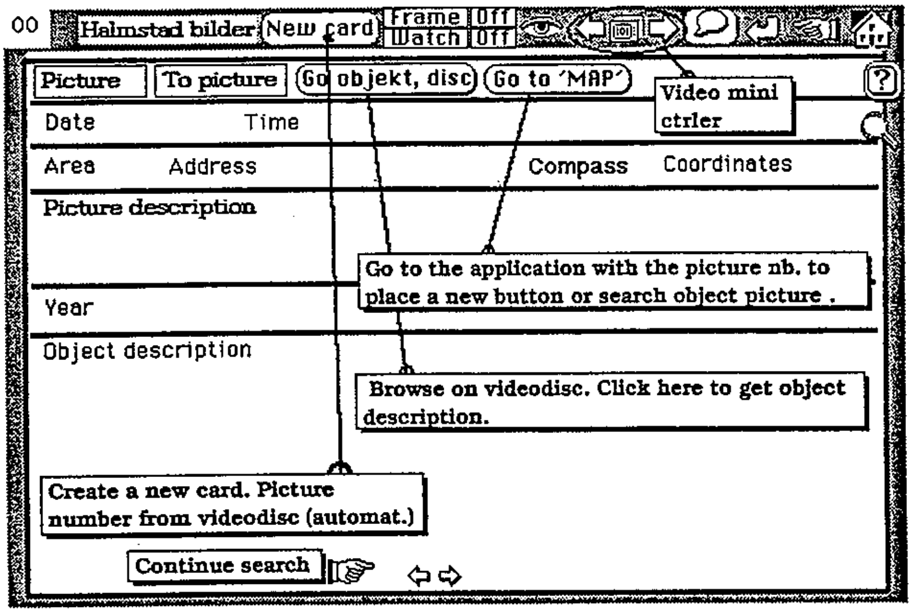

Figure 8. A card to describe an object in the 'Halmstad object index' stack of the City advisor hyper document

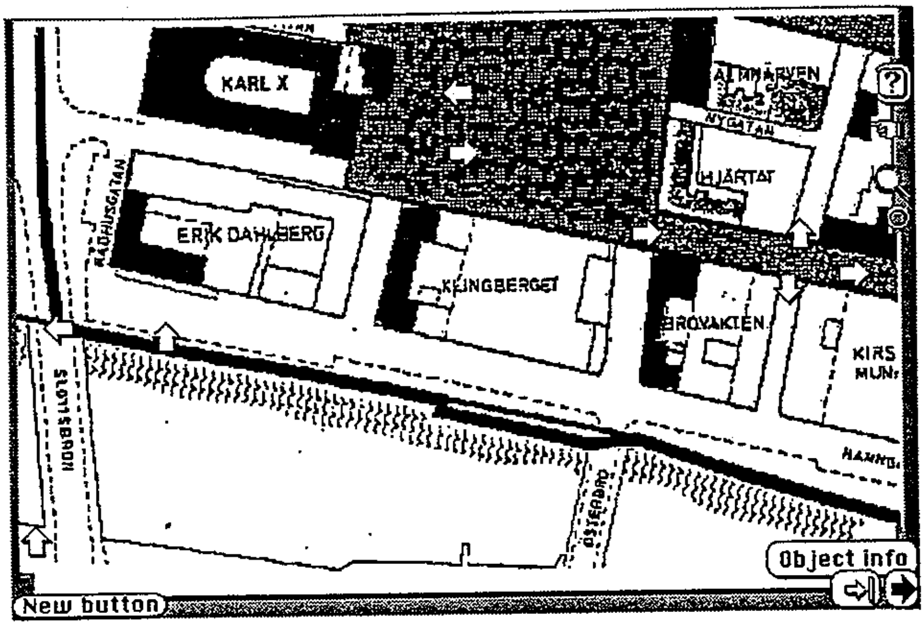

Figure 9. Part of the geometric model ´MAP´ of the the City advisor hyper document

<u>Use</u>   <u>Build</u> (expand) the hyperdocument

- browse the videodisc pictures and create new cards for the objects, (see figure 8), repeat (building object index)
- check if an object (found as picture on the video disc) already has an object card (´go object, disc´ button, figure 8)
- browse object cards (which are linked to videodisc pictures) in the object index stack

- Go to ´MAP´ (´*Go to MAP*´ button) from object index stack navigate to a place and create a reference with the ´*New button*´ tool. A new reference (button) is created as well as its script for proper linkage to the picture of the object . The card script is also updated to contain a comment about the new button on it. (building ´MAP´)

- get information about displayed object by pressing ´object info´ button in the ´MAP´stack (will pass control to the ´object index´stack).
- Browse videodisc pictures or object cards and search the ´MAP´ for an object (look out for flashing arrows)
- Call an advisory expert at any time

The short comments above gives an idea about how a hyper document might be developed and used.We can browse in a information space that are flat with a visible structure. We can search and dive adding more search dimensions. We can acquire knowledge which can sharpen our search. We acquire deeper knowledge about the model/document. We can add new knowledge to the document and we can get information from the document on how to use it.

7. THE FUTURE

After a few relatively calm years we can now expect a rather turbulent evolution of computerized tools aiding the building process and its final results the product and its users. Many different solutions to the 'same' problems will be formulated, tested and hopefully compared (adding to our experience/knowledge). Integration will take place on a higher level than before (loosely linked models) with great emphasis on styles of communication and the way we describe work, products etc.. Hyper documents will also function as interfaces and supports to other systems (manuals, interfaces to databases and calculation programs etc.). Research on knowledge representation (mix of) and knowledge acquisition will be intensified. Machine learning mechanisms and rules will be meaningful to study, again. Knowledge transfer between people and cultures must be intensified. Hopefully cross fertilization and collaboration between different interest groups and 'experts' will increase and creativity flow.

8. CONCLUSIONS

The paper describes and exemplifies how modern information technology may impact the properties of future computerized building documents and models. It is also emphasized the importance of capturing, testing and communicating ideas as we give up many known methods and tools Examples have been picked from ongoing research under the heading KBS-MEDIA, knowledgebased systems - media. The research is supported by the Swedish Building Research Council and by Apple Computer, Novacast AB, Esselte System AB and The Swedish Building Centre.

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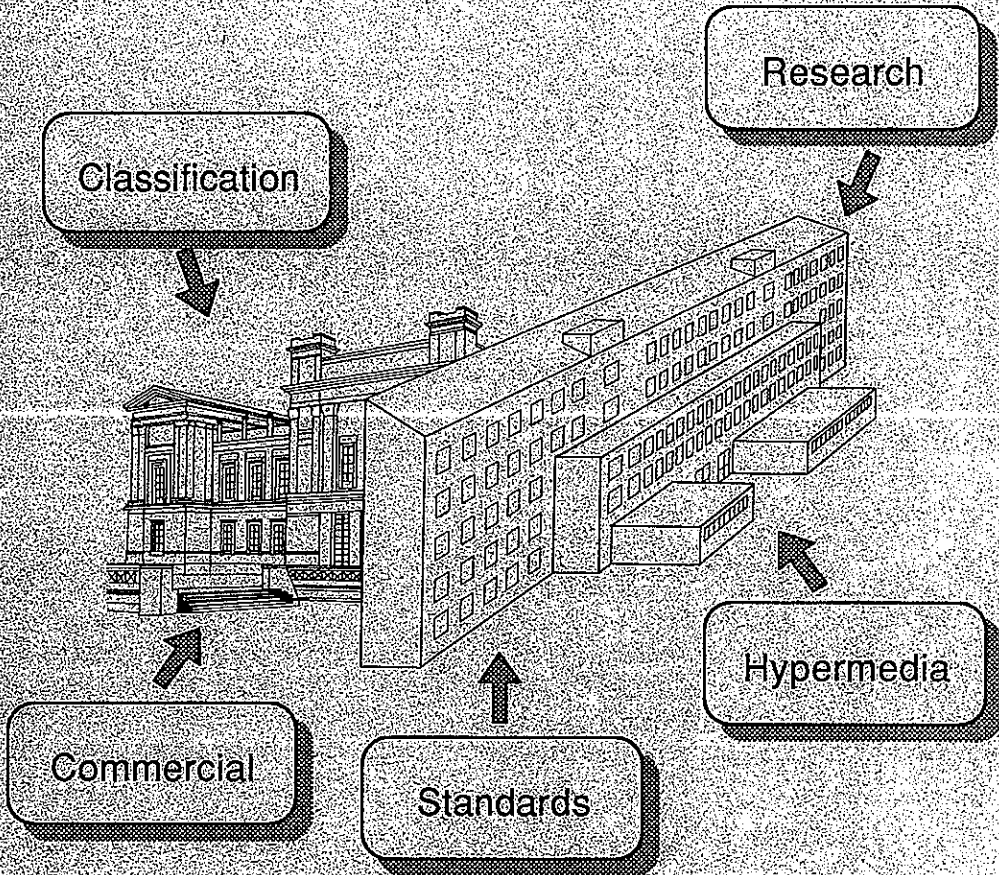

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PREFACE

The seminar was a co-arrangement by the two CIB, The International Council for Building Research Studies and Documentation, working commissions W74, Information Co-ordination in the Building Process, and W78, Integrated Computer Aided Design. The practical arrangements were organized by Lund University in collaboration with the Swedish Building Centre, Stockholm.

The main objective with the seminar was to exchange knowledge and to bring together people who are active within the areas of computer aided design, classification and standardization in the building process, product modelling in construction and commercial developments of computerized systems within those areas.

The seminar was officially supported by: (1) The Swedish Council for Building Research, (2) NBS-DATA, The Nordic Building Research Cooperation Group, Working Group for Information Technology and (3) The Systems Committee of the Swedish Building Centre.

We wish to thank all participants who contributed to make the seminar a very valuable and important event in the area of conceptual modelling of buildings. 20 countries were represented with a total of 90 delegates. Especially we want to thank those persons presenting papers, the organizing committee and the local secretariat at the department of Structural Engineering at Lund University and Lund University Rectorate who put down a great effort in planning and carrying through the 4 day seminar. We also want to thank the NCC Inc., Skanska Inc. and the Swedish Telecom for the well arranged study visits during the fifth day of the seminar.

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