Advanced information technology in building maintenance support

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Abstract
In the existing KBS-MEDIA (knowledge-based systems - media) environment demonstrators have been built to support different phases in the building process; Building Maintenance, Material and Vendor Information, City Advisor, etc. In this environment new concepts and tools are tried out in connection with using, building and maintaining of the systems formed by advanced software and new media. New tools for building and using the systems have been defined, created and tested.
Demonstrator systems from projects concerning 'Building Maintenance' and 'Material and Vendor Information' are referred to in the paper. On application level the users have access to the underlying facts bases (also audio/visual) and tool boxes through a context dependent interface. Existing databases are also transferred to the system. Background agents are created to help users/system-builders to control the access and growth of the systems during use. Different representations are used (analogical, hypertext, relational databases, neural nets, decision trees, object-oriented, etc.) which are loosely linked, more or less formalizing our real world. There is great emphasis on the user interface which has multimedia properties. The systems form demonstration environments used to capture, test, and communicate ideas so allowing fast prototyping of the next generation of integrated systems for the building industry.

1. INTRODUCTION

Since the autumn of 1987 work has been going on to build a KBS-MEDIA (knowledge-based systems-media) environment at the department of Structural engineering at Lund University. The environment hosts the development of *demonstrator* systems which are used to capture, test and transfer ideas among system end users in the building process and the

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system builders/tool makers. Demonstrator systems from projects concerning 'Building Maintenance' and 'Material and Vendor Information' are referred to in the paper.

We are now in a turbulent phase of evolution where we are shifting paradigm from what we can call industrial capitalism to something new. We are trying to identify possibilities and risks in using the new technology. We are constantly formulating new concepts and "agreements" are slowly radiating from new patterns of thinking and acting. Theoretical and practical trials are now required. In various situations, how can we support and enhance our intellect, and improve communication between people by using computers? How do we communicate our experiences? It was easier before when we could formulate isolated models (reproductions) for different problem domains. These often rather static models were put into computer systems using the available software. And so we will continue to do, but we have (or will have) to formulate the *rules* which govern the *growth* of the systems. Yesterdays programmer will become tomorrows *toolmaker*. It is very important that we try to transmit possible efficiency gains to something that will raise quality. For example to give us more time for a thorough study together with a client in the early phases of a project and comprehensive as built documentation for successful later use and management of the building and its facilities.

The systems we are formulating today may provide us with dramatically better communication tools (communication rooms, personal "telescreens", virtual realties etc.). Behind the system interfaces dwell more and more capable representations which closely relate to search strategies and those parts of reality that we try to model. See also (Christiansson, 1990a, 1990b, 1990c).

The project "Advanced Information Technology in Building Maintenance Support" the "Delphi" project is now in its final stage. The project is carried out together with The Lund Academic Society (dwelling foundation) with contacts to the Swedish Building Regulation Authorities. The end users are people involved in building maintenance and tenants. Information about some of the 5000 flats that the students have access to in Lund is stored in the system as data in a database and as images on a video disk. Two scenarios have been studied - hiring out flats and the repair of laundries.

The project aims to:

(1) study the possibilities and limitations of new information technology in connection with advanced systems for building maintenance support,
(2) contribute to the formulation and conceptual modelling of such systems,
(3) provide a demonstrator as a vehicle for future development within the area.

2. THE KBS-MEDIA CONCEPT

More details about the knowledge-based systems-media environment can be found in (Christiansson, 1989a, 1990b). The most powerful features of the KBS-MEDIA environment are:

* clearer and more obvious connection between *application* and computer stored *models*
* *integration of advanced software* tools as knowledge-based systems, neural nets, hypertext and relational databases
* simplified *knowledge elicitation* and *dynamic* growth, change and validation of models
* use of different *knowledge representations* in cooperation (object oriented, decision trees, neural nets, relational databases, frames, analogical, symbolic, procedures, hypertext, rules, etc.) and *search strategies* (map analogies, pattern recognition, tracking, etc.)
* provision of *adapted tools for problem solving* (decision support, information browsing and search, model building and maintenance tools, background agents, navigation palettes)
* design of powerful *man - machine* interface
* tools to *access*, *collect* and *handle* very large *information volumes*

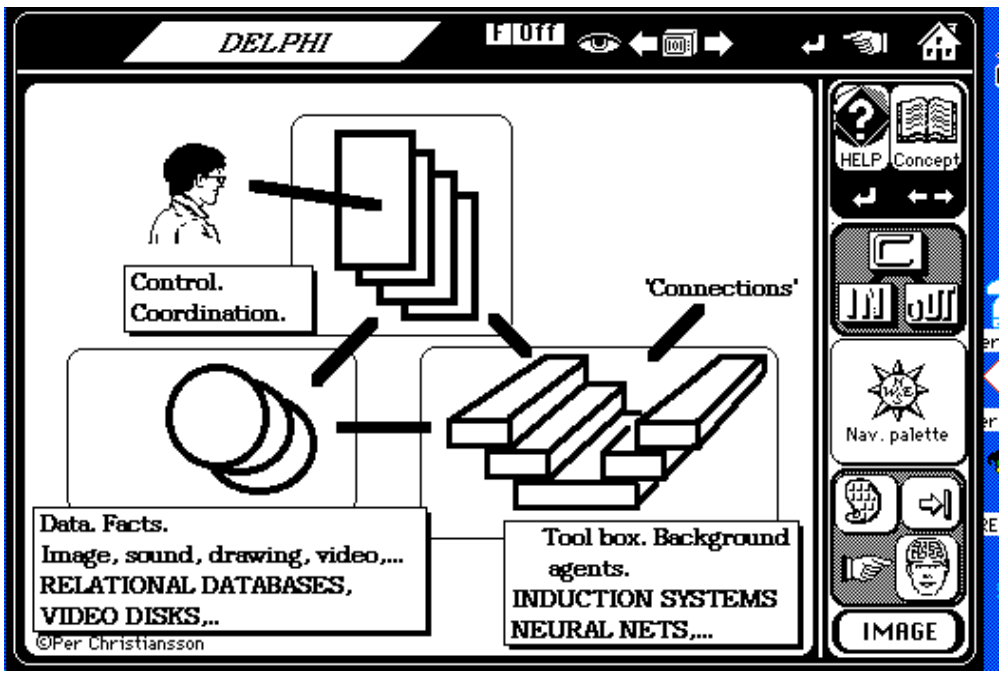

Figure 1. Logical layout of a demonstrator of a building maintenance system. Ideas are captured, tested and communicated between end-users, researchers and "tool makers" in the demonstrator.

* computerized models supported by *real life pictures* and *sound* as well as *computer generated* pictures, drawings, animations and sound.
* *integration of optical distribution and storage media* to support different computer stored models
* *tools for acquisition* and *handling* of *large volumes of pictures*
* powerful tool for *knowledge transfer* (training, education, communication and spread of information)
* fast and simple *prototyping*
* *Demonstrator* for the capture, testing and communication of ideas.

Figures 1 and 2 show the logical layout of the demonstrator in the KBS-MEDIA environment. The main control of and communication with the system is performed by the *user* through a *context* container. For example the in-context holds information about user descriptions (property manager, craftsman, hire department, tenant etc.), activity (repair, hire etc.), output specification (brief output, complete report, message delivered), special access conditions (learn/navigate modes, filters), and tool settings (active/passive agents etc.). The context is view dependent and stored in a HyperCard program.

Separate *facts bases* belonging to the application are connected; (a) alpha-numerical information in relational databases, (b) images, film, sound on optical videodiscs, (c) text, sketches, speech, animations in HyperCard and (d) images and drawings on hard disk or CD ROM. The *tool box* contains context dependent tools such as navigation palettes, special advisory

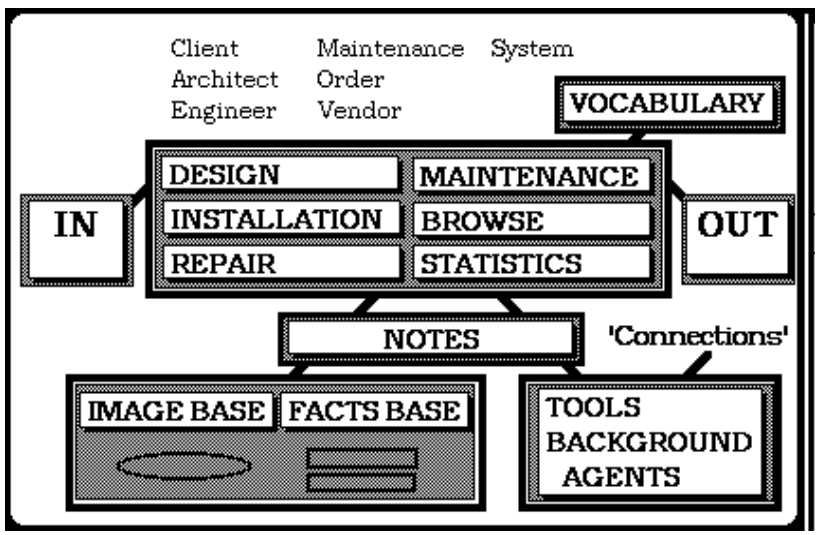

Figure 2. Logical layout of the "Delphi" demonstrator. Three levels are distinguished: The context level with different views (maintenance, repair, hiring etc.) to the system, the facts bases and tools/background agents and the intermediate notebook or short term memory.

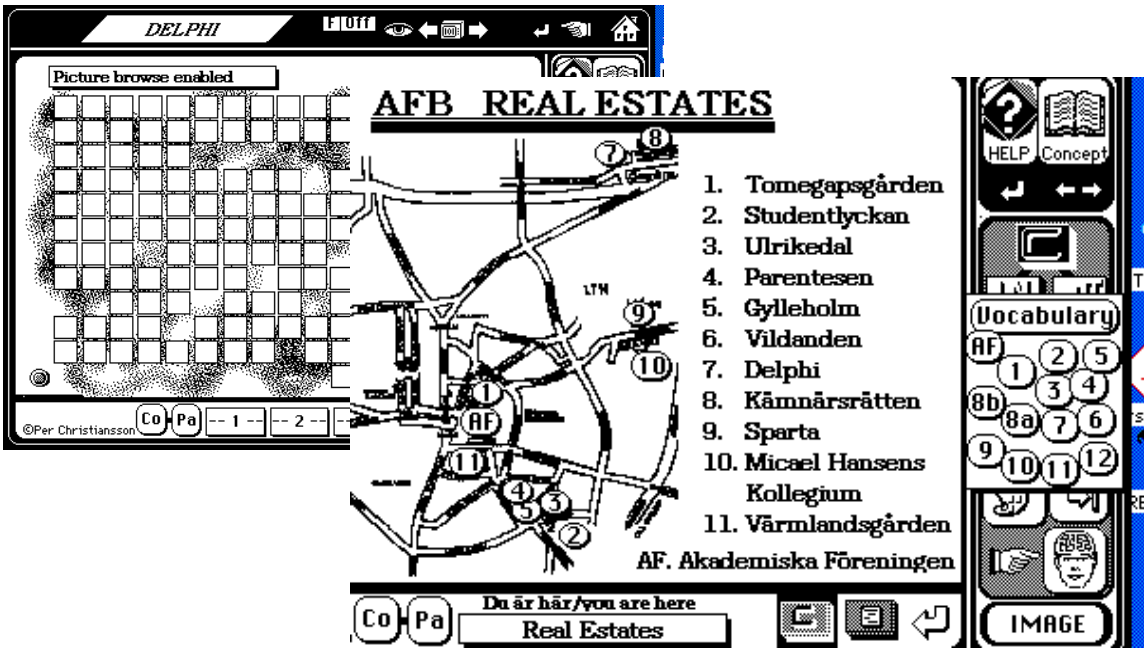

Figure 3. Navigation palettes and "agents" details from the "Delphi" demonstrator.

agents, help agents, application specific procedures, model building agents, vocabularies etc. *Background agents* possess knowledge about applications or computer tools (sometimes the border is not sharp).

In the KBS-MEDIA environment the *background agents* use induction systems, neural nets and HyperCard stored procedures. Communication between users and the system takes place in the context environment. This communication passes *short-term memories/"note-books"* which are also used by the background agents. Normally the note-books only have to be visible to the user on request or under certain views.

The following *hardware* is used: Apple MacIIs, videodisk- and CD ROM players, B/W scanner, S-VHS Video-camera and recorder, sound sampler and video digitizer. The main *software* packages are HyperCard from Apple Computer Inc., Cupertino, SuperExpert (induction system) from Intelligent Terminals Ltd., Glasgow/Novacast AB, Ronneby, see also (Christiansson, 1986), MacBrain (neural nets) from Neuronics Inc., Boston (Chait and Jensen, 1988), Swivel 3D (3D modelling) from Paracomp Inc., San Francisco, MacroMind Director/VideoWorks II (to animate Swivel models) from MacroMind Inc., San Francisco, and Oracle (relational databases) from Oracle Corporation, Belmont.

3. KNOWLEDGE REPRESENTATIONS.BUILDING AND USING THE MODELS.

Among other things, the success of the conceptual modelling of an application is dependent on available tools, agreed definitions and vocabulary for the application, and available representations and search/reasoning capabilities. In the KBS-MEDIA environment the formulated models are loosely coupled containing partially redundant information due to openness for different views and varying detail levels on the information. Under influence of "connectionist" thinking and distributed representations this circumstance may be reassessed.

Existing data structures and information volumes (like real estate data, tenant/hiring information and maintenance system) have been slightly transformed and integrated with new information like images on videodisk. The conceptual modelling activities have largely been performed through scenario development together with end users (maintenance people and hiring department).

Different users have different access rules to the system. If the system is in LEARN mode the user has access to model building tools otherwise it is only possible to navigate in the information space and extract information. Navigation and search mechanism is reinforced by among other things: (1) the multi media interface, (2) multiple search paths, (3) associative search, pattern recognition and information maps, (4) navigation palettes and browse tools and (5) help from background agents and guided tours.

4. CONCLUSIONS

This paper describes and exemplifies how modern information technology may impact the properties of future building maintenance systems. Examples have been picked from ongoing research under the heading KBS-MEDIA LAB, knowledge-based systems media lab.

5. ACKNOWLEDGEMENTS

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