# BACKGROUND AGENTS TO ENHANCE ACCESS AND GROWTH OF LOOSELY COUPLED MODELS FOR BUILDING DESIGN.

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## Abstract

In the existing KBS-MEDIA (knowledgebased systems - media) environment demonstrators have been built to support different phases in the building process- City Advisor, Material and Vendor Information, Building Maintenance etc. In this environment new concepts are tried out in connection with using, building and maintaining the systems formed by advanced software and new media. New tools for building and using the systems have been defined, created and tested. The users have on application level access to the underlying facts bases (also audio/visual) and tool boxes through a context dependent interface. Background agents are created to help users/system builders to control the access and growth of the systems. Different representations are used (hypertext, analogical, relational databases, neural nets, decision trees, objectoriented, etc.) which are loosely linked and more or less formalizing our real world. The user interface has multimedia properties. The decision and knowledge transfer process is enhanced by the systems giving individuals and group of process participants access to adequate tools. The hyper documents which are created possess powerful man-machine interface and dynamic model building properties. The system which is shown at the conference forms a demonstrator environment used in different applications to capture, test and communicate ideas admitting fast prototyping.

## Keywords

Agents; man-machine interaction; knowledge representation; hypermedia; artificial intelligence

## Introduction

Since the autumn 1987 the work on building a KBS-MEDIA (knowledgebased systems-media) environment has been carried through 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 system builders/tool makers. References are made to some of the ongoing work and some thoughts and ideas on the future are also given.

We are now located in a turbulent phase of development where we are shifting paradigm from what we can call the industrial capitalism to something new. We try to see possibilities and

risks in the new technique. New concepts are constantly formulated and "agreements" slowly radiated from new patterns of thinking and acting. We must onward perform some tests. How can we in different situations by using computer support enhance our intellect and enrich communication between people? How do we communicate our experiences? It was easier before. We then often formulated isolated models (reproductions) in different problem domains. After that we put those often rather static models into the computer systems using available software. And so we will continue to do. The news is that we have (or will have) to formulate the rules which governs 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.

The history of thinking machines can for example be found in (McCorduck, 1979) and (Johnson and Brown, 1988). A comprehensive collection of papers on Neurocomputing are assembled in (Anderson and Rosenfeld ed., 1988) from McCulloch and Pitts paper, 1943, on "A logical calculus of the ideas immanent in nervous activity" to the later, 1988, achievements in the field. The history of hypertext, a non-sequential writing and reading medium build up by nodes of text chunks (and graphics ) and links between them, is listed in (Conklin, 1987). The pioneers within the field were Vannevar Bush (the 1940s) and Douglas Engelbart (the 1950/60ies-) and Ted Nelson (the 1960s-).

**The KBS-MEDIA concept**

More details about the knowledgebased systems-media environment can be found in (Christiansson, 1988, 1989a, 1990a).

The most powerful features of the KBS-MEDIA environment are:

* clearer and more obvious connection between application and computer stored model
* integration of advanced software tools as knowledgebased systems, neural nets, hypercard 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.)
* offer 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
* 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 great picture volumes
* powerful tool for knowledge transfer (training, education, communication and spread of information)
* fast and simple prototyping

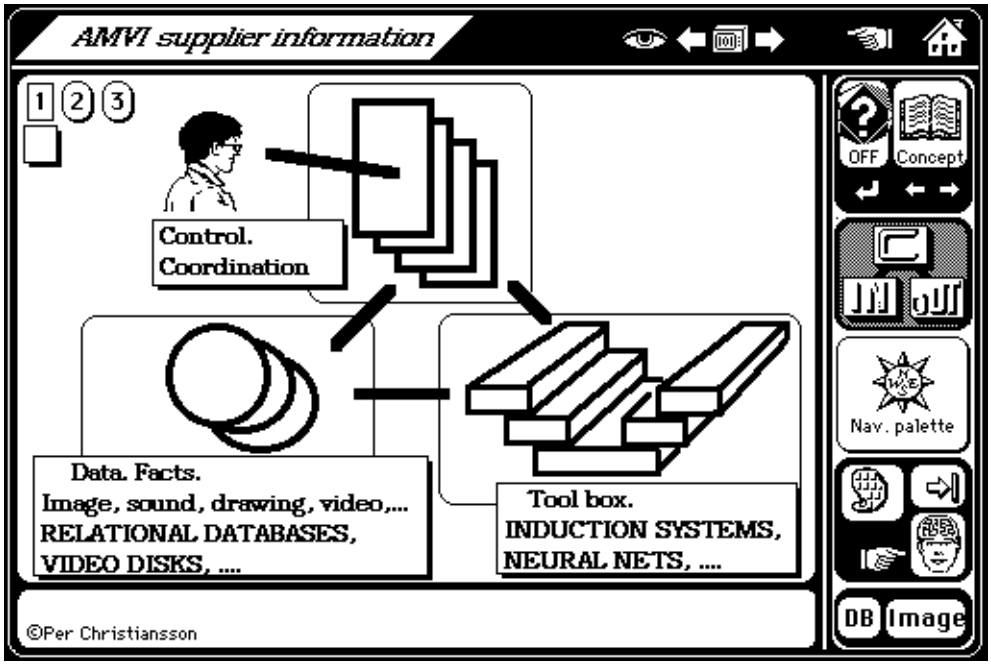


**Figure 1.** Logical layout of a demonstrator of a material vendor information system. Ideas are captured, tested and communicated between end-users, researchers and "tool makers" in a demonstrator.The project was carried out together with and supported by the Swedish Building Centre. From Christiansson (1990a).

* Demonstrator for capture, test and communication of ideas

Figure 1 shows the logical layout of a demonstrator in the KBS-MEDIA environment. The main control of and communication with the system is performed by the user through a context container. The in-context holds information about for example user descriptions, building process phase, additional specification of views to the model, 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 (see below).

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 as navigation palettes, special advisory agents, help agents, application specific procedures, model building agents, vocabularies etc. Background agents possess knowledge

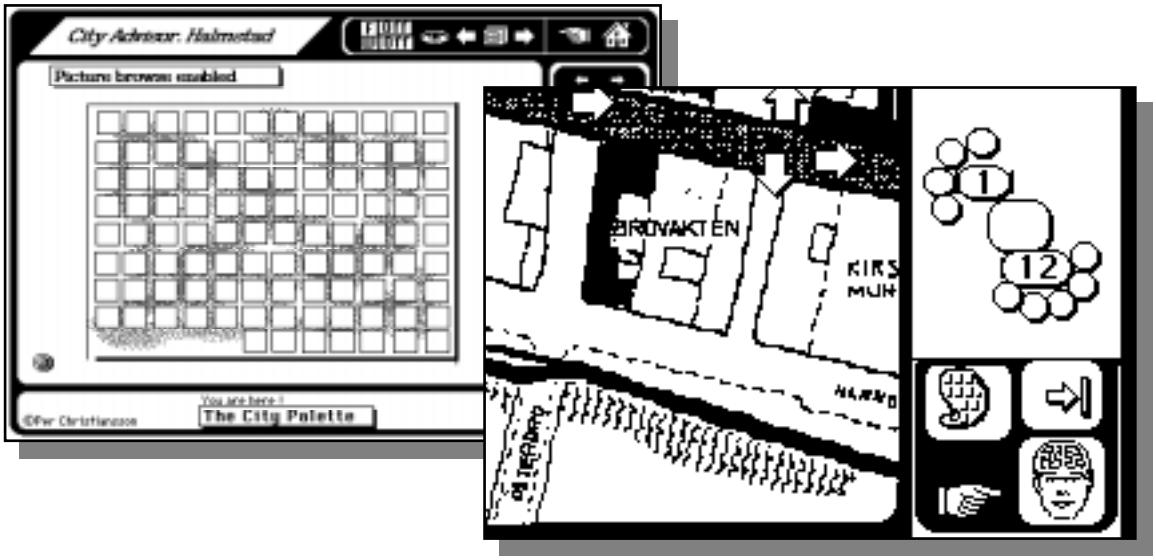


**Figure 2.** Navigation palettes and "agents" details. From Christiansson (1988) and Christiansson (1989a).

about applications or computer tools (sometimes the border is not sharp).

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 Videocamera and recorder, sound sampler and video digitizer. The main software are HyperCard from Apple, MacBrain (neural nets) from Neuronics (Chait and Jensen, 1988), (McLelland and Rumelhart, 1988), SuperExpert (induction system) from Intelligent Terminals Ltd, see also (Christiansson, 1986) and Oracle (relational databases) from Oracle Corporation.

**Knowledge representations. Building and using the models.**

The success of the conceptual modelling of an application is among other things 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.

Neural net based background agents talk with the users and context descriptions in a pattern oriented fashion. Agents can help the user recognize partially described patterns (graphic or textual). Agents can also recognize internal system states. The neural nets use different learning strategies, activation

functions and topology (also hidden layers). The nets (as well as the relational database) are on system level controlled via the HyperCard script language and special linked in procedures (so called external commands, XCMD). The access of the nets and databases is more or less transparent to the user dependent on user profile and user view to model. The neural nets can expand during use of the system. See also (Christiansson, 1990a).

**The future**

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 (closely related to search strategies). See also (Christiansson, 1990b). It will be less relevant to distinguish between hardware and software. Next generation hard-software is already available in the form of neurochips or bigger Thinking Machines (Hillis, 1985). Capacity rises and prices fall.

It will now be very fruitful to try to formalize some of our thoughts about thoughts - like Minsky´s society of agencies (Minsky, 1986). We need vocabularies and languages to express properties and behaviour of advanced representations. We might even come up with a 'quantum theory' for machine "thinking".

Some issues and ideas for the future:

- how do we constrain system growth and how do we (they) manage unlearning and retraining?
- a language for pattern communication
- driving forces for agent/pattern activities. It might be meaningful to experiment with "agent personalities" - expectations, wills, rewards, habits, ..
- distributed representations. Dynamic agent representations and definitions. Procedural - Holistic thinking.
- new "neural net" topologies/connection patterns. Search for general theories. Time influence - activation patterns.

We may already be located in a new Renaissance era. Traditional science disciplines mingle. Inventions and carrying thoughts are born in creative environments. We need our Lionardo da Vinci´s (1452 - 1519) and science heroes. But our main goal must be to formulate artifacts that fulfill our wills and wishes. Those artifacts should have characteristics that are not so well developed in us humans.

**Conclusions and acknowledgements**

The paper describes and exemplifies how modern information technology may impact the properties of future building information systems. Examples have been picked from ongoing research under the heading KBS-MEDIA LAB, knowledgebased systems media lab. The research is supported by the Swedish Building Research Council, Lund University, The Lund Academic Society, The Swedish Building Centre and by Apple Computer, Novacast AB and Esselte System AB.

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