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Dynamic Knowledge Nets in a changing building process *

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Hypotheses and explanation models are put forward about the future global structure, manipulation and transfer of knowledge. The so called Dynamic Knowledge Nets, DKN, are defined and used to explain changes for the next generation of computerized communication and knowledge handling systems. More and more powerful tools become available to model and visualize different parts of our reality. These tools will influence our possibilities to create useful models and will also have a great impact on how these models are integrated and accessed. Behind the interfaces dwell more and more capable integrated knowledge representations which are closely related to pertinent search strategies. It is now possible in a changing building process to create models which bring about a clearer and more obvious connection between the applications, our intentions and the computer stored models. The systems we are formulating today may thus provide us with dramatically better communication tools as communication rooms, personal "telescreens", and virtual realities. We must formulate and try out new concepts. New tools for building, using and maintaining the next generation systems have been and are continuously created and tested at the KBS-MEDIA LAB (knowledge based systems-media) at Lund University. Examples are given outgoing from ongoing research mainly the Material and Vendor Information and Building Maintenance Systems as well as Decision Support at the Building Site. These systems can shortly be described as multi agent environments with multimedia context dependent user interfaces to underlying facts bases.

Keywords: Building process; Dynamic Knowledge Nets; knowledge based systems; knowledge transfer.

1. Introduction

In this paper I try to procure a pattern to support understanding of the monumental metamorphosis going on in society. Some factors and hypotheses are presented in the paper. It is of great importance that we try to build up a higher degree of consciousness among all people in order to get an increased understanding of what is going on and how we can individually and cooperatively influence the development of the 'global village'.

We are facing very big changes in our society on all levels and in all areas. Where is man in this gigantic transformation towards a global village with its highly developed infrastructure for information transfer and handling. What is said here is of course not only valid for the building process but for many aspects of our society.

We can already see a high degree of *specialization* in our working lifes. This may lead to a frustrating *fragmentation* where we seem to loose touch with the whole of matters. It may also lead to *cooperative* working conditions with fruitful competence combinations. One of the most important issues are the growth of explicit and implicit rules for how communication patterns develop and information filtering are done in the future gigantic global network which we may call the *Dynamic Knowledge Network*, DKN.

In this paper I am putting forward ideas about the future global structure, manipulation, and transfer of knowledge. The so called Dynamic Knowledge Net, DKN, is unveiled and used to search, explain, and manage changes for the next generation of computerized communication and knowledge handling systems.

2. Turbulent changes

2.1. Domains

The *local villages* were rather well defined regions. The knowledge, knowing and religious

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belief of the domain (local region) was stored in the heads of its inhabitants and transferred by oral tradition and symbolism. (Symbol = something that represents something else by association, resemblance, or convention. Symbolism = the representation of things by means of symbols. The American Heritage Dictionary). Storage and transfer was later supported by written formalised rules in the form of laws or guiding principles. Information in documented form could also be transported by man or by man and horses etc. Knowledge embedded in things must still be transported if the thing is not very well documented in for example a digital model. In this latter case the information about the model may be sent in electronic form.

As communication and transport between villages became more common the need for formalized inter regional affairs was emphasized. Regions were in most cases closely linked to the concept of geographical regions. See Fig. 1.

In the *global village* there will also exist regions. These may though be more constituted by other concepts than geographical regions because of access to effective communication resources. Important non-geographical regions in the global village may be; ethnic regions, as found in the cities of USA, company based/industrial regions, like in Japan and emerging in Europe, cultural, and religious regions. The four freedoms of the European common market are defined as freedom for flow of goods, jobs, money, and people. Regarding development of corporate structures see also [1].

New rules for inter-human and inter-regional affairs are formalized with or without our conscious participation in 'the global village'. People may belong to many 'regions' at different periods of their life. The regions boundaries will also change dynamically over time as well as their definitions. As usual the *optimal* or *satisfying* solutions to problems on the regional level will often not coincide with solutions satisfying individual human beings—problem with simultaneous optimization in domains and sub-domains.

The existing formalized rules (-xxism) may be characterized in todays paradigm by the relation of market driven (bottom up) and plan economy (top down) driven processes in the global village (Fig. 2).

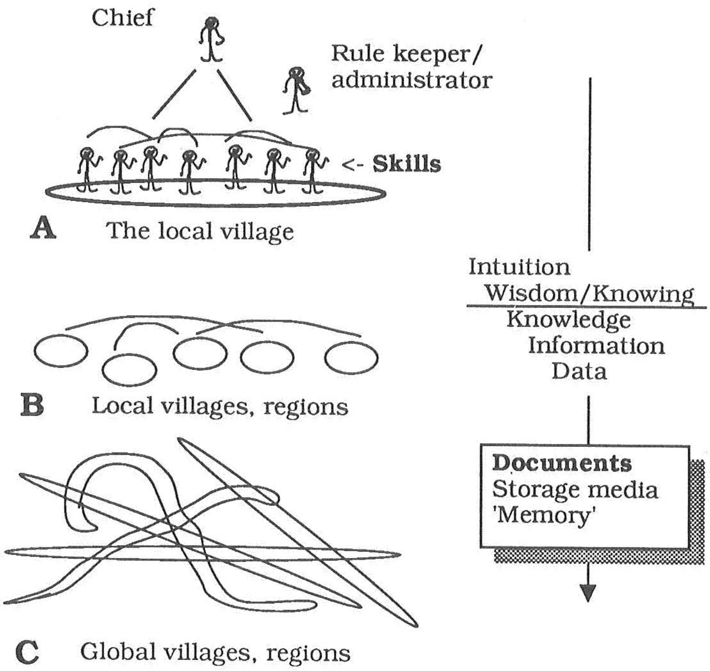

Fig. 1. Three stages of domain development: (A) the local village; (B) local villages/regions; and (C) global villages/regions. Rules for interaction in (A) are tacit (moral), religious, or explicit (in laws or guiding principles). Information became more and more effectively documented.

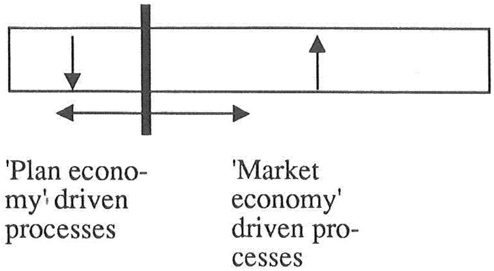

Fig. 2. Top-down and bottom-up formalizations of the administration of human and regional affairs. Formalization is 'stored' in more explicit rules in the 'plan economy' case.

The basic resources/energies we have available to improve human and global conditions are
- humans (labour, brain, competence). (Competent = adequate for a *purpose*);
- material/energy;
- capital/by humans refined material; and
- information/knowledge.

In 'the global village' we will trade with knowledge items. We will also invest in knowledge residing both in the head of humans and in computer systems. Already today we have difficulties assigning value to a knowledge company in a purchase situation. Do I just buy a corruptible company where knowledgeable people are very unstable capital? Will the gaps between groups of people widen due to greater emphasis on intellectual skills? Will we develop an 'electronic altruism' [2]. Maybe, maybe not.

2.2 Communication and transport

Communicate (to make known, transmit; according to the American Heritage Dictionary) can be defined as a low energy means of moving information. *Transport* (to carry from one place to another) is the corresponding high energy mode of moving things or knowledge.

Some years ago it was said that we should enter the paperless society when the computer became extensively used. The opposite happened. Now with the introduction of man to man communication in networks we will probably travel more to be able to meet all these interesting people we are confronted with through the network. The air corridors over Europe is already full and the railways under intense build up.

In the global city we have less 'secrets' then today. Information is often transmitted to buffer zones (integrated with the DKN) which can be reached at any point of time. Information will be sent (transport layer in communication vocabulary) in packets (Fig. 3). These packets can rather easily be opened, i.e. copied, as a non legal act. After they have been copied an eventual crypto can be solved. The routines for handling digital communication in a *secure* way has still to be developed.

As said before we will probably for good and bad be more specialized in our skills. *New type of jobs* will be more needed in the area of knowl-

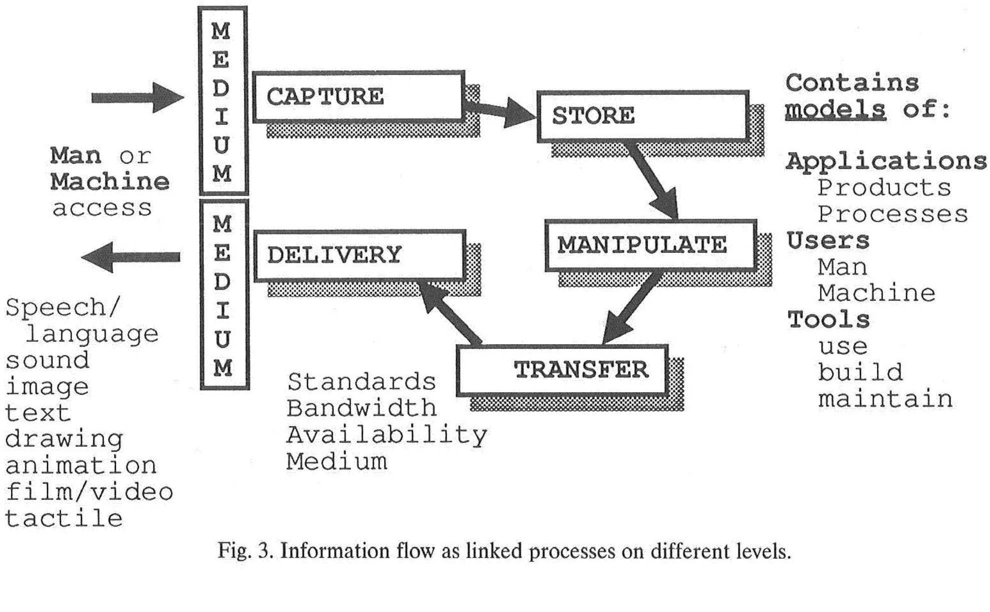

Fig. 3. Information flow as linked processes on different levels.

edge coordination, packing and transfer. Some groups of people may be telecommuting. More loosely united organisations may be temporarily established to perform certain tasks. This will be more true for non physical production undertakings. We may get a renaissance for good craftsmanship in all senses.

2.3. Knowledge structures

During the passed century the so called 'industrialism' has been the ruling paradigm. We are now in the phase of changing to something new which we could call '*globalism*' ('the global village') or '*organizm*' (from organization and organic). During the industrialism there was a need for man skill in the realm of logics (area A in Fig. 8) to make known processes more effective. Today we need more non-parametric studies and creative thinking (area B in Fig. 8) to formulate and try out sometimes totally new processes on all level in our society.

The global village metaphor is convenient to use when we make associations to the original human societies (in modern time or for us known eras). The big difference is that we now have to take into account a global communication and knowledge infrastructure, DKN, that do not have to be a foot print of existing formalized processes for inter human relations.

How do we define the different abstraction levels of information. One rather straightforward view is:

- Intuition (un-formalized wisdom);
- Wisdom/ knowing how-why/ skills (human knowledge added. May be tacit knowledge);
- Knowledge (interpreted information);
- Information (grouped data);
- Data.

It is also fruitful to try to make comparisons between the human thinking processes and corresponding activities in computerized systems from local to global level. Such explanation models are put up today. See for example [3] with a society of minds in our body or [4] using the new notion of thick and thin boundaries in the human minds. In this paper we talk about long and short neuron connections as a guiding parameter to discuss basic structures and properties for both human mind and computerized systems.

2.4. Time

Former high level civilizations are not unlikely. We though have few artifacts from that time to support documents seemingly showing proofs of

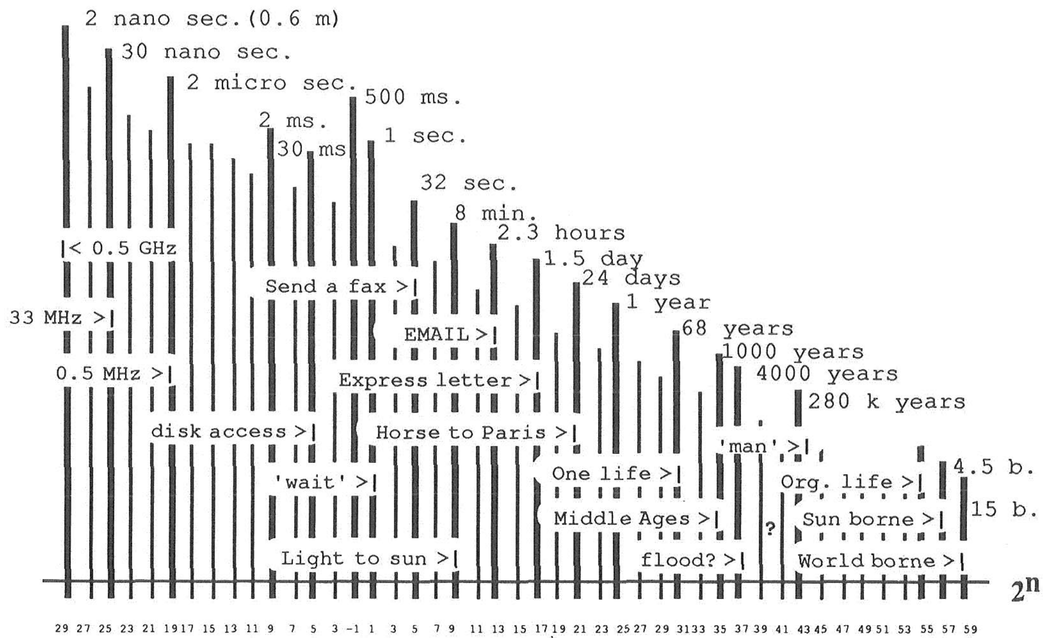

Fig. 4. Time expressed as 2^n seconds with n from -29 to 59.

technically very well developed civilizations. May be we are looking for the wrong things or they were washed away during the big eventual flood 2800 B.C. Some people believe that due to unfortunate circumstances the industrialism did not begin during the Middle Ages.

Time and space are very strong factors influencing our world image. As the DKN becomes more real both factors will constrain communication less than before. In the time of local villages the Vikings could misbehave at the shallow borders of 'The Netherlands' for decades (8 : th century) before the exposed people realized that the Vikings used flat-bottomed ships. Today we can follow the attack machines in real time on satellite transferred television news. That is we know in detail what happens within seconds all around the world (where there is a net).

As human beings we experience simultaneousness when we get response within fractions of a second. Talking in a telephone or using (desk-top) video conference gives a real time experience and human parallel processing. Conferencing in an EMAIL environment is not a simultaneous two way communication. Controlling a distant eye on a the planet Mars is not done in real time as it takes 4–30 minutes for a signal to travel between Earth and Mars. This is one reason for us to develop small local eye-brains (retina neural-nets) to help artifacts navigate on Mars.

As we approach time spans near 2 nano seconds the speed of light gets annoyingly low. Light will only travel 0.6 meter during 2 nano seconds, see also Fig. 4. This means that co-processing (parallel processing) within a group of computers also must take place within a limited distance.

2.5. Formalization

In the global village there will be language barriers. What will happen in Europe? Will the common language be English? Yes probably. Language barriers also exist between different computer stored models. These are semantic issues which are tackled in the research and standardization fields.

Do we want to talk with artifacts? Voice mail is used now more and more. Many people get annoyed to be sent around a company by synthetic voices. It is working very well when the output for example is the balance of your bank account and the latest transactions or a weather forecast etc.

Figure 5 gives some ideas about critical issues when creating the 'fork' through which we interact on a complex information volume. It may also well be the space that travels through the fork and us, where we are mentally at rest. The higher the *degree of formalization* the more "effective" the computerized models will be and less flexible to changes, see Fig. 6. It is of course a question about optimizing in a set of constraints as:
- ease of system maintenance;
- flexibility to new type of projects;
- storing application experiences;
- robustness of the model;

Multidimensional spaces:
room, time, resolution, ..

Media:
Text, sound, images, animations, speech,film,...

Search paths:
Alternative routes, tracking, analogies,..

Filters:
Zoom, perspective/fish eye, resolution,...

Help:
Agents, navgation/browse palettes, guided tours, information maps, experiences,...

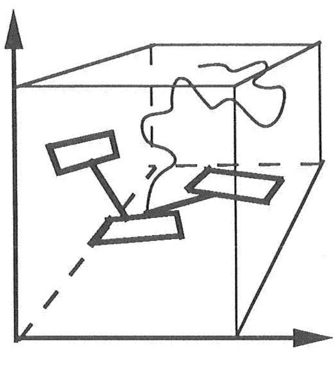

Fig. 5. Search in huge and complex information volumes requires special tools and strategies (9).

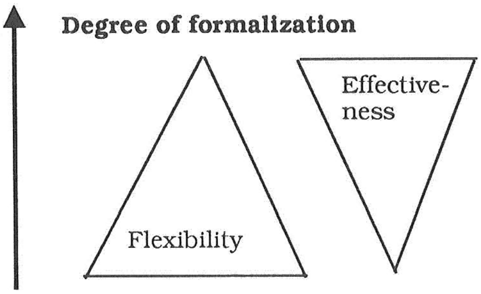

Fig. 6. There might be a negative correlation between effectiveness and flexibility for different representations.

- communication with other models;
- degree of distributed models;
- information content and volume. Modelling domains;
- how is the information created and maintained;
- style of communication (symbolic, pattern oriented, look at, augment the model etc.);
- knowledge transfer domain (education, training, instruction, time validity, regions, etc.).

It should also be emphasized that we do not necessarily achieve quality gains in making processes more effective or efficient. On the contrary it may lead to a kind of society epilepsy where things develop to fast without visible order.

Formalization on higher levels are studied especially in the research communities. Different problem areas are tackled for example; how can dynamic integration of knowledge modules be performed, how can semantics be embedded in CAD systems for use in translation between design tools [5], automatic exchange of data among a suite of building performance evaluation tools [6], computational processes as mutation and analogy to support creativity in Computer-Aided Design [7], and Integrated Design and Construction Planning [8]. From [10]: "It will now be very fruitful to try to formalize some of our thoughts about thoughts—like Minsky's society of agencies [3]. 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,...

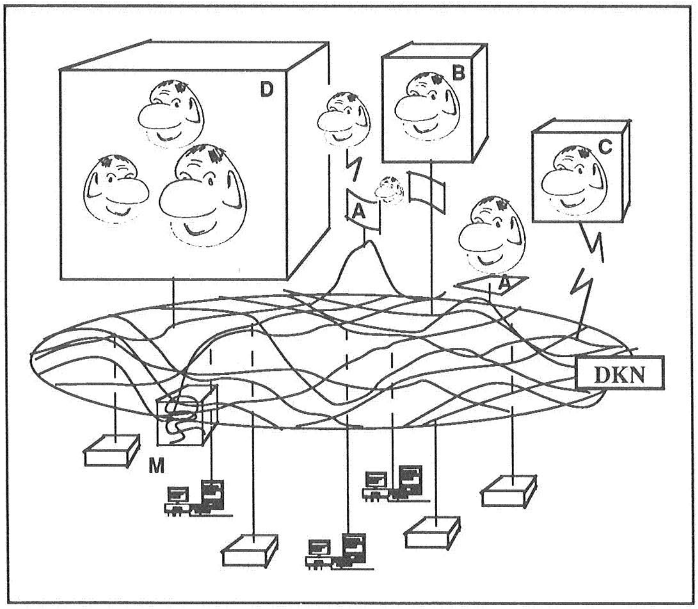

Fig. 7. The Dynamic Knowledge Nets connects man and machine. The worldwide DKN may enforce direct (D) or indirect man interaction-cooperation. Machines (M) may contain part of the physical DKN. The time to establish connection may vary from nano-seconds to minutes. The DKN dynamically changes its connection or activity patterns. A knowledge chunk is a 'stabile' connection pattern.

- distributed representations. Dynamic agent representations and definitions. Procedural–Holistic thinking.
- new "neural net" topologies/connection patterns. Search for general theories. Time influence–activation patterns.

3. New concepts

In order to support further discussion and understanding of ongoing changes, the global net and its functions is described in the so called Dynamic Knowledge Net, DKN. The structure and properties of the net is characterized by its relation and presence of long and short connections, i.e. information transfer lines. Finally some concluding remarks are given on the human connection and organizational behaviour in the DKN.

3.1. Dynamic Knowledge Nets, DKN

Dynamic Knowledge Nets connects man to man, man to machine, and machine to machine and may *also* be regarded as an integral part of machines. It may enforce direct or indirect man interaction/cooperation, see Fig. 7. Today we can perform a very delayed conversation using EMAIL (electronic mail for text, voice, image, film) or computer supported meetings. The direct connection of man B and C in Fig. 7 can be established today in special video conference networks or using desk-top ISDN, Integrated Digital Services Network based communication. If B and C are going to be part of the same virtual reality and work on the same artifact in real time very high demands are put on the DKN in terms of bandwidth, compression and decompression routines, parallel cooperating processes etc. For example; two persons operating on the same damaged power station together with a muscle and eye extender (robot) or a design team collaborating with the building site on a design alteration. We already face problems in distributed multimedia networks. Virtual realities can though be practised at game arcades.

The dynamic knowledge net is thus the physical network to connect persons, organisations/processes, and computer tools. (See also Fig. 3). Connections in the Dynamic Knowledge Nets, DKN, may be established in *time* and *space*. The *linkage media* may be hardwired in the form of copper or fibre wires or performed through continuous media as space and water.

We can (1) *establish connection* to knowledge artifacts in the DKN. Knowledge and information may be reached much easier than today in for example a digital library. We may (2) *combine* different knowledge sources during short (seconds) time instead of having to dig in books for years. We may also be able to (3) *analyse patterns* not practically reachable before. For example; (done today in Japan) make remote sensing analyses of critical land slide zones from satellites, or do historical evaluations of phenomena described through information from many sources. The result/patterns can be *presented* in a very user adapted way (virtual realities, dynamic patterns etc.).

The net access points will in many cases be *location independent*. Today the mobile telephone system is rapidly built out (also the fixed stations with personal access code). This also implies that the network has to 'know' where you are, to be able to establish connection when you are searched for. This may be regarded as a serious threat to human integrity. How personal should the computer be? Are we going to introduce the concept of the everywhere (ubiquitous) computer which always is available everywhere you are [11], or a more personal computer or will they merge. At Xerox PARC the researchers have 'everywhere' access to tools like 'liveboards' (electronic black-boards) and smaller 'pads' and 'tads' as opposed to the personal computer.

Man is borne with a basic *set of connections* which probably may be extended through training and learning new skills, 'brain jogging'. Society is now reborn/rebuilt with a new set of potent connections. The number of connections are everyday increased as the combined computer/telephone net is built out (copper, optical fibre, microwave links, infrared light, radio and satellites). The ISDN is already facing its next development to Broad ISDN, BISDN, with capacity of 150 Megabits per second.

3.2. Long and short connections

The human brain contains a huge number of neurons which are connected via dendrites and axons. In the artificial neural networks we try to

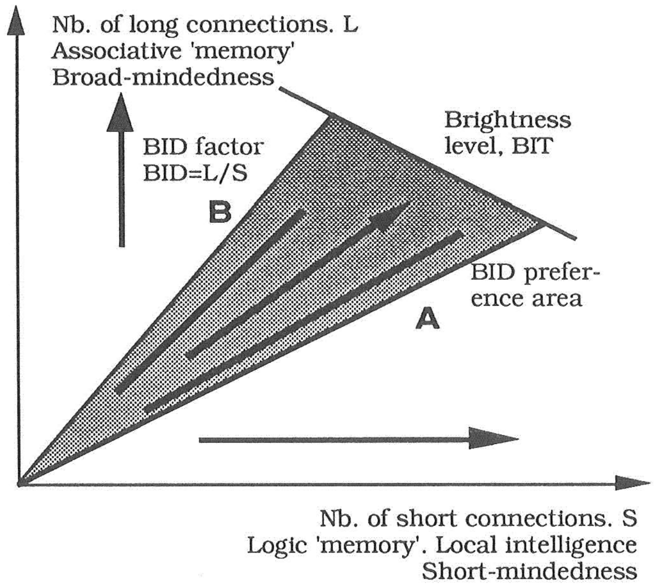

Fig. 8. The relation and presence of long and short connections are supposed to describe artifact and even human brain qualities. A long connection may traverse many neurons. The preference BID factor is paradigm dependent. Low (near A) during the industrialism. Now approaching B with a wider preference area.

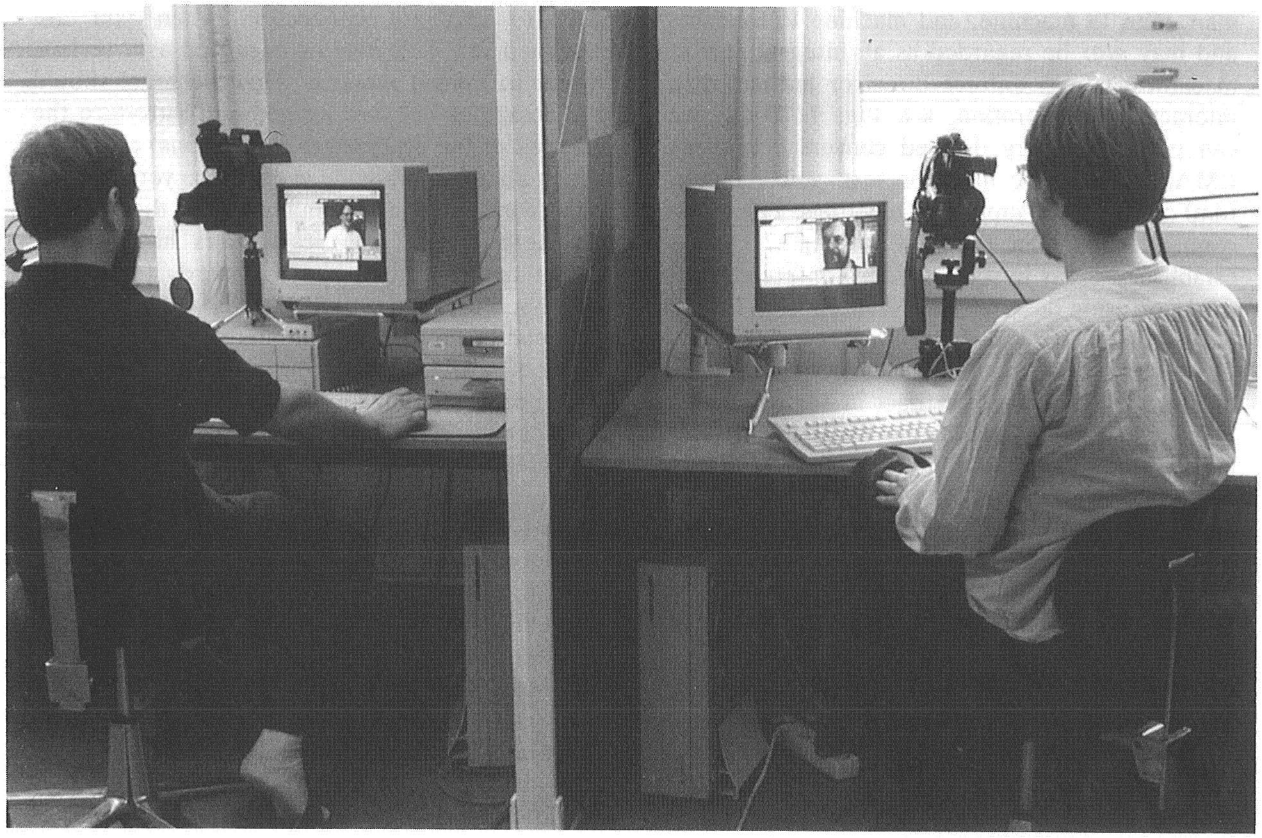

Fig. 9. Desk-top Video in the KBS-MEDIA laboratory before one computer is transferred to a building site. Project "Decision Support at the Building Site".

mimic the brain behaviour or construct artifacts with new properties. The brain activities are not (cannot be) known in detail. May be small chunks of neurons for example perform what we could call logical operations to control body actions and respond to external stimuli. These chunks in its turn are more or less tightly connected forming higher level chunks and so on. On higher abstraction levels it may be very hard for us to understand, formalize, the underlying processes. What is *intuition*? It may be the result of interaction between sparsely connected long distance chunks supported by local chunks. This could also mean that intuitive thinking is less constrained by local phenomena both in space and time (broad-mindedness).

As a working model two basic connectionist parameters, *BIT* brightness level and *BID* long to short connections relation, are put forward to express the relations between and presence of long and short connections in a neural net system both biological and artificial, see also Fig. 8.

The area A in Fig. 8 may partly correspond to thick boundaries and B to thin boundaries in Hartmanns mind topography [4].

Critical issues in these discussions are *learning* properties and the ability for the computerized systems to *un-learn* or forget on different *abstraction levels*. Learning may for example be performed in artificial nets by means of induction [12] or training of auto-accociative memory. Often during this exercise we—the human trainers —learn a lot about the problem under consideration. According to Fig. 3 we can assume that processes occur on different levels. This is important when we construct neural networks. On lower levels we may for example transfer a 2-dimensional image to a 1-dimensional distribution (occurrence frequencies of image properties). On a higher level this partly classified image then can be interpreted effectively. But we must not forget that the act of designing *neural network topologies* is a real peice of art.

3.3. Human connections

We can now develop cheap desk-top communication tools, where we even may communicate using low resolution live video, see Fig. 9. This is a rather primitive communication mode but also a first step towards powerful terminals of the Dynamic Knowledge Net, DKN. Below some problem areas are listed concerning human connection to the next generation computerized systems.

- How do we express new *rules for human relationship in the global DKN* (security, faxtalk, broadcast, electronic group behaviour, personal agent behaviour, filtering mechanisms, etc.).
- How do we build up a *corporate identity* in new flexible organisations (companies) with lots of telecommuting employees.
- Mechanisms for *artifact unlearnig*—change of development tracks (we can end up with or enforce any type of society and basic values moral).
- Human system *control*. Voice and gesture *controlled* systems.
- How do we measure and evaluate *social* and business *intelligence*.
- How will the job *planning* and *decision process* be modified due to organizational changes.
- How can creation and widening of *class gaps* be minimized.
- Creation of new ways to define *detail levels/* resolution when accessing the models through "connectionist" thinking. That is to dynamically connect knowledge chunks in varying patterns.
- Effectively elaborate the notion of *objects* representing different parts of the building process and building/urban product models. *Product* tracing.
- Creation of *views* adapted to different users needs and situations.
- Formulation of *rules* which govern the *growth* of the systems (defining tools and basic representations).
- Definition of *search tools* and *strategies* (media, search paths, filters, help functions etc.) in balance with *mixed* knowledge *representations*. Information *coordination* strategies.
- Creation of system environment that are more easy to *maintain* and change than todays systems. New *working tasks* due to DKN.
- Define and use *(hyper)documents* which partly will contain building process/product models. These documents will be much more than for example a conventional spread sheet (Fig. 10).
- Usage of *multimedia* properties in the user interface and control. For example in simula-

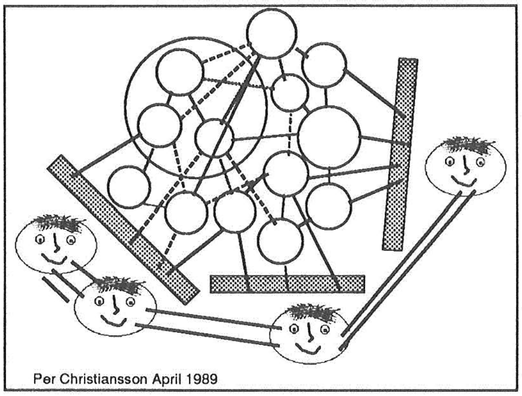

Fig. 10. The hyperdocuments form an integral part with computer stored models. Knowledge is aggregated on different abstraction levels.

tions, virtual realities, communication between building process participants etc.
- How can the systems serve as vehicles to let us better *understand* the reality we are working in (see for example the demonstration systems mentioned later).

Only a few problem areas are listed. During the transitional period we have to intensify experimental and theoretical research and development and also make comparisons between a multitude of solutions.

4. The KBS-MEDIA environment

We are now in a turbulent phase of evolution where we are shifting paradigms. We are trying to identify possibilities and risks in using the new information 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 (Fig. 11).

In 1990 a *National Building IT program* was started in Sweden and three centers were established at the Institute of Technologies in the cities of Lund, Gothenburg and Stockholm. The Lund Center is called ITBL—IT Building Center at Lund University. ITBL involves researchers at the Civil Engineering and Architecture Schools at Lund University. Within ITBL we are carrying through and starting up research within areas such as: product modelling, building process participants co-operation, vendor/product information for early design and maintenance, new con-

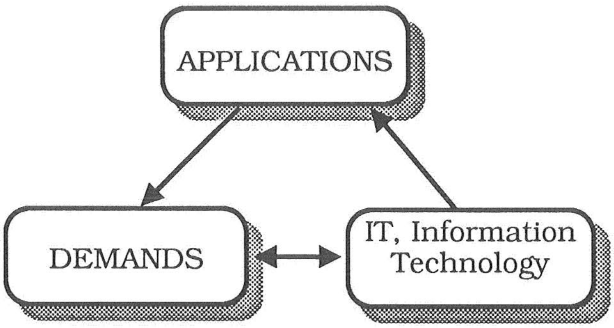

Fig. 11. There is a necessary mutual influence between the applications and information technology domains for short and long term problem solutions.

cepts for building and handling computerized building process models.

4.1. The KBS-MEDIA Lab

Since the autumn 1987 the author have been responsible for building up the KBS-MEDIA (Knowledgebased Systems-Media) environment at the department of Structural engineering at Lund University, see also [13]. *Demonstration* systems have been and are built to support different *applications* in the building process, for example: City Advisor [14], Building Maintenance (the DELPHI-project) [15], Material and Vendor Information (AMVI) [16], and Decision Support at Building Site. The KBS-MEDIA Laboratory at the Civil Engineering School at Lund University also carries through *basic research* concerning representation, search, and building up of knowledge, knowledge transfer, and Dynamic Knowledge Nets. Several representation forms as neural nets are tried out as well as advanced multimedia environments for simulations, communication and virtual realities.

The KBS-MEDIA Lab hosts the development of *demonstration systems* which are used to capture, test and communicate ideas among system end users in the building process and the system builders/ toolmakers. We integrate *advanced software tools* and *optical media* which enables us to use different *knowledge representations* in cooperation (object oriented, decision tress, neural nets, relational databases, hypertext, analogical, calculation procedures). We define adapted *tools for problem solving* for different problem domains (decision support, information browsing and search, model building and maintenance tools, background agents, navigation palettes).

Among other tools we have developed special browse tools to traverse and handle the information space for example in the form of *palettes* for browsing video images, navigational palettes, product browse palettes etc. All the time the *background agents* are there to help you. We get a more obvious and clear connection between *application* and computer stored *model*. We have defined and developed tools to *access*, *collect* and *handle* very large *information volumes* in computerized models supported by *real life* pictures/ films and sound as well as *computer generated* pictures, drawings, animations and sound.

4.2. Software and hardware platforms

4.2.1. Software

The main software components in the KBS-MEDIA environment are: HyperCard from Apple Computer Inc., Cupertino, SuperExpert (induction system) from Intelligent Terminals Ltd., Glasgow/Novacast AB, Ronneby, see also [12], MacBrain (neural nets) from Neuronics Inc., Boston [17], Oracle (relational databases) from Oracle Corporation, Belmont, Swivel 3D (3D modelling) from Paracomp Inc., San Francisco and MacroMind Director/ VideoWorks II (to animate Swivel models) from MacroMind Inc., San Francisco.

The HyperCard program from Apple Computer Inc. has properties of both hypertext and object-oriented programs, although it is not a classical object-oriented system. Some programs have been written in HyperTalk which is a local script language in HyperCard. For example the interface to the Oracle database we have written in HyperTalk using special external commands, XCMDs, delivered with the database. Portions of live video is also recorded, digitized and stored on hard disk as well as compressed (JPEG) still images (QuickTime from Apple Computer).

4.2.2. Hardware

MacII computers from Apple Computer Inc. are used as well as PC-compatible computers. Video signals from for example the videodisk or colour video cameras (Panasonic Super-VHS camcorder or a Canon ION still image camera) may be displayed on the computer screen instead of on a separate TV-monitor. Video images can also be grabbed in real time and stored in digital form on for example a hard disk. The Multimedia Screen Machine card from Fast Electronic GmbH, Pfinztal/Idea AB, Väddö, is used for real time frame grabbing and live video display on the computer screen. Images may also be scanned into the systems by means of colour and black & white paper scanners. Sound (voices, music, etc.) is scanned in and stored in digital form on hard disk.

Besides hard disk (and CD-ROM) optical disks in the form of videodisks are used to store images and film sequences. Two videodisks were produced (1986, 1989). These optical media possess different qualities, influencing which should be

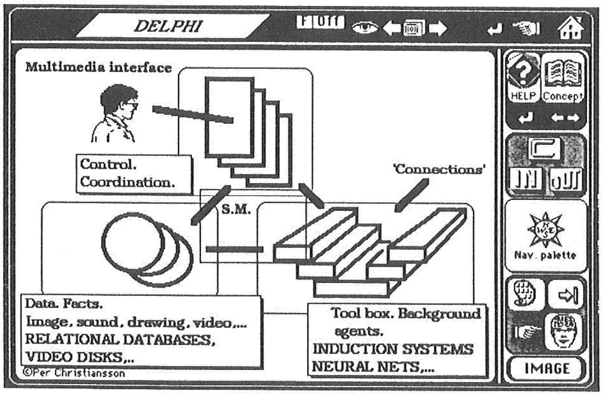

Fig. 12. In the KBS-MEDIA (Knowledge Based Systems-Media) environment demonstrators are dynamically built. "*Background agents*" use induction systems, neural nets and Hypercard stored procedures. Communication between users and the system takes place in the *context* environment. This communication passes *short-term memories*/"note-books" which are also used by the backgrounds agents. Separate *facts bases* belonging to the application are connected: (a) relational databases; (b) images, film, sound on optical videodiscs; (c) text, sketches, speech, animations in Hypercard; and (d) images, films and drawing on hard disk or CD ROM.

chosen for any given application. Important factors are the type of information (stills, film, sound, etc), the size of the edition, the validity over time of the stored information, whether the disc will have multiple applications, how the information will be maintained, and how information is collected and transferred to the optical medium.

Below some of the applications which are developed in the KBS-MEDIA environment are shown together with brief descriptions of system functionality.

4.3. Examples from the KBS-MEDIA Lab

Figure 12 shows the logical layout of the demonstration systems 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, application views, 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.

Figure 13 shows two levels of the geographical map of the City Advisor (the city of Halmstad). Navigation is performed by clicking at the map or with special tools (navigation palettes, text search in image descriptions, search for image references on the map etc). Figure 14 shows some more examples on navigation and image browse palettes.

4.3.1. Facts bases

The facts bases, see also Fig. 12, are the long term memory of the applications. Data stored in a relational database is of course more easily

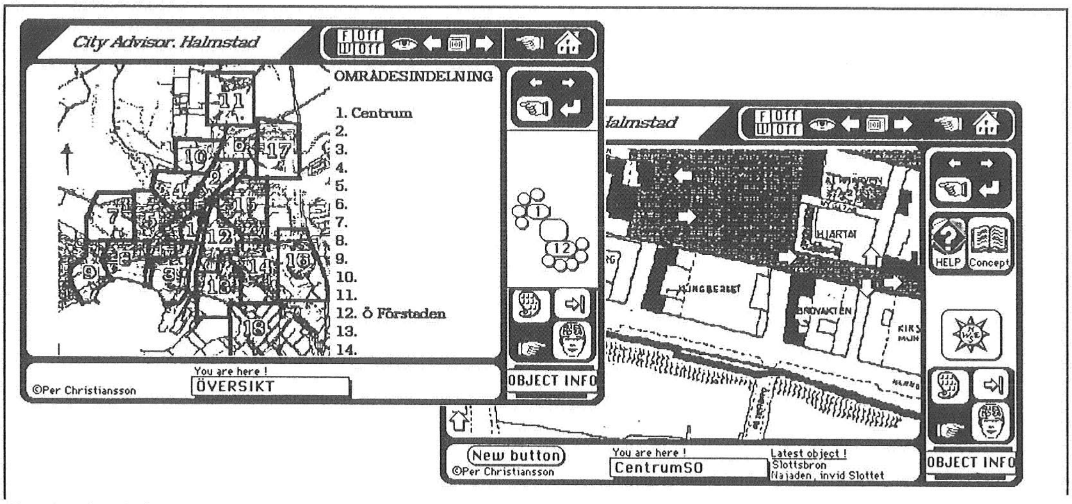

Fig. 13. Two levels of the geographical map of the "City Advisor" of the city of Halmstad in Sweden. Navigation is for example performed by using the navigational palettes, text search, clicking at the map or search for image references (the arrows to the right). Special tools are available to augment the model [14].

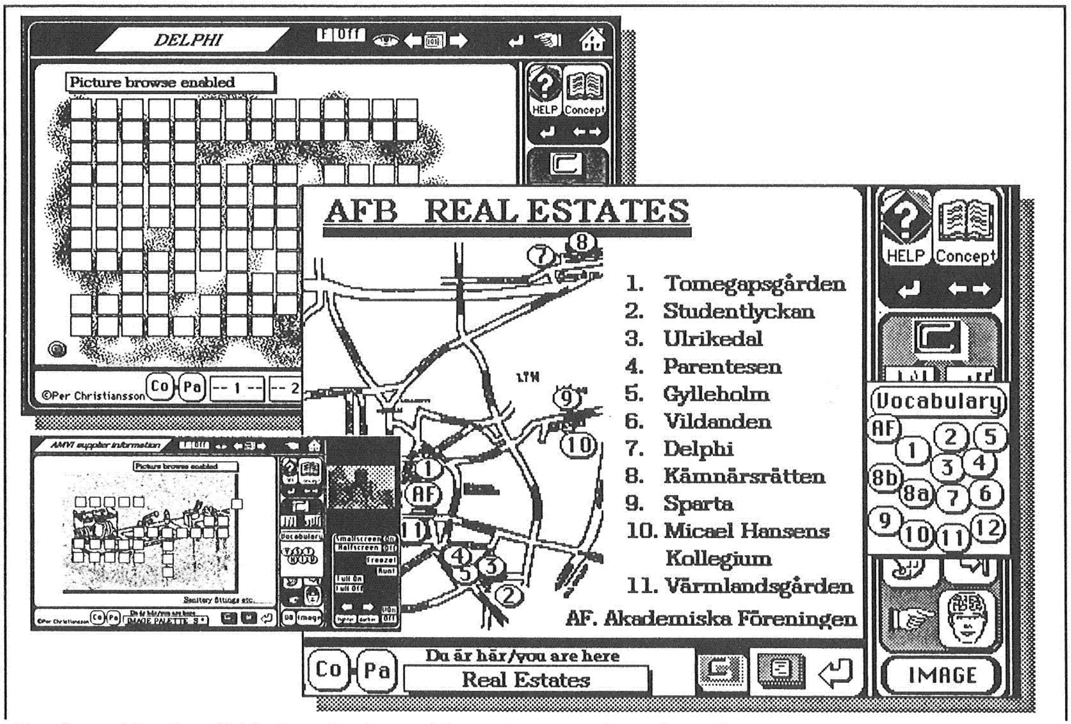

Fig. 14. Touch sensitive (no clicking) navigation and image browse palettes from the "Delphi" demonstration system (Building Maintenance) [15,16].

changed and expanded than the images on a videodisk or a CD-ROM. The facts bases provide data (together with the user input) to build up context descriptions during use of the system. The KBS-MEDIA systems contains facts of different format and content:

(a) alpha-numerical information in relational databases;
(b) images, film, sound on optical videodiscs;
(c) text, sketches/drawings, speech, animations in HyperCard, animations in Micro Mind Director/VideoWorks II and Swivel 3D, digital film on hard disk (Figs. 15 and 16);
(d) images, films and drawings on hard disk (or CD-ROM).

4.3.2. Short term memory / Note book

The user and background agents have access to a short term memory or note book where intermediate data are stored. While traversing the information space the user may at any time mark (highlight) and copy text he wants to be remembered temporarily. Part of the note book handles communication between the 'context' and the relational database Oracle. Database queries are translated to SQL sequences in the note book (that is the language that Oracle understands)

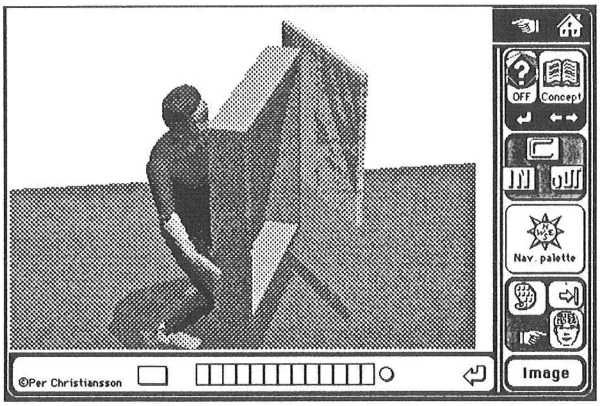

Fig. 15. Animations and video sequences gives instruction on how to install and repair windows (from the Material and Vendor Information System, "AMVI"). The animations are created outside and controlled from inside HyperCard. Advice and help are provided by the background agents in the systems. For example to help you to create slide show with verbal instructions on window renovation. Animation and videodisk stored objects can be rotated via the horizontal bar.

and sent to the database. The result is returned and sent back to the context via the note book. The user has to her/his disposal a vocabulary where old and new definitions and concepts are stored. The vocabulary is created during system build up and use. See for example [16].

4.3.3. Agents and tools

In the systems there are tools in the form of background agents which can perform a series of tasks. The agents are knowledgeable about the *application*, the *user* or the *system* itself.

Below a list is given on some of the tasks that

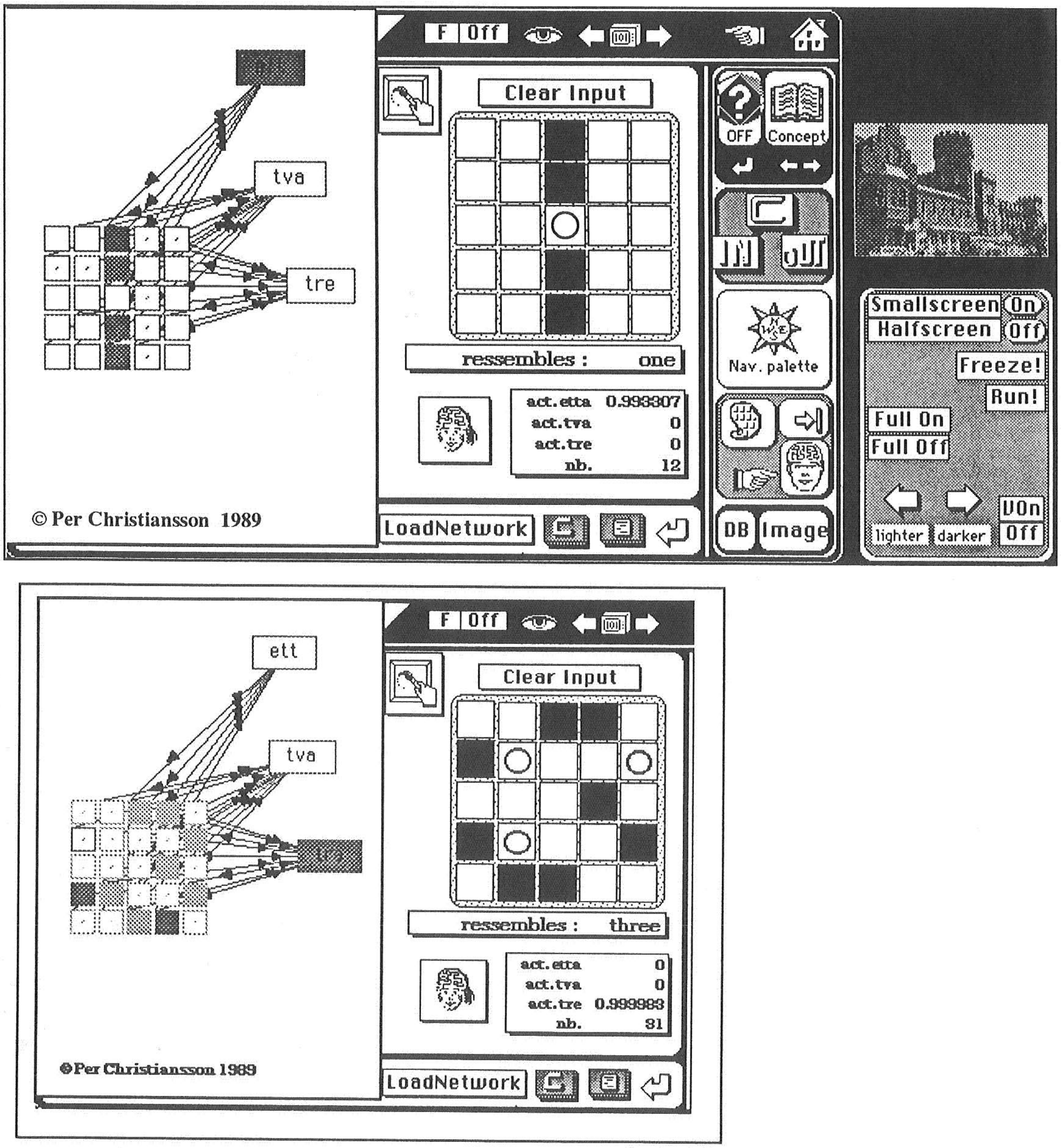

Fig. 16. A background agent in the form of a neural net is integrated into the HyperCard stack. Pattern can be recognized. For clarity the Hopfield network which was trained outside HyperCard recognizes a "one" and "three" pattern. The missing input squares are marked in the figure (circles). The net is normally not displayed on the screen. (In the upper right corner is a reduced videodisk overlay image.)

are performed by the agents and tools in the KBS-MEDIA systems:
- help user create image browse palettes, image descriptions and image references
- fetch data in the relational data bases
- search for image references in the context descriptions
- create slide shows (using images on videodisk and sound from image descriptions)
- give advice on specific application problems (bridge selection, regulations, etc)
- provide the user with navigational and image browse palettes
- update context descriptions
- communicate with external procedures
- etc.

4.3.4. The scale effect

When demonstration systems are scaled up some problems may have to be taken into consideration in more detail. For example:
- How are information systems distributed and maintained? On line/off line and combinations.
- How is existing information integrated into the systems?
- Where do information reside? Distribution on main frames and personal workstations.
- How can we for example extract specific information out of 20 CD-ROMs containing needed data. New services required?
- How is multi user access handled?
- Copyright issues.
- Security problems.
- Cost-capacity relations. Efficiency issues.

4.3.5. Concluding remarks about the future

The paper really deals about the future about which we only can guess. The transformation to a new era have already started. The future information technology support is developed in an imposing speed; sensors, human control, bio computers or wetware, miniature body robots, etc. The area of 'intelligent buildings' has not been directly referred to in the paper.

5. Conclusions

Hypotheses and explanation models are put forward about the future global structure, manipulation and transfer of knowledge. The so called Dynamic Knowledge Nets, DKN, are defined and used to explain changes for the next generation of computerized communication and knowledge handling systems in the 'global village'. Also as a working model two basic connectionist parameters are put forward which expresses the relations between and presence of long and short connections in a neural net system both biological and artificial. Examples are given from ongoing research at the KBS-MEDIA LAB at Lund University.

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