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KNOWLEDGE COMMUNICATION IN THE GLOBAL NETWORK

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Abstract. The next generation design systems will be developed in an user and network environment which force us to think along partially new paths. We will define meta models to ensure integration efficiency. The paper focuses on the relation between models representing user, product and process for the building application and IT-tools domains within an overall context description. The aim with the paper is to present a setting, ideas and hypotheses as a guide for the future development of Computer Aided Architectural Design Systems in a time of accelerated changes pace. A three level computer stored knowledge layering is presented and analyzed - the personal, company/project and global levels. The impact from evolving networked object systems, augmentation processes, publishing and access filtering is enlightened. A collaborative design scenario is presented influenced by new communication media and underlying integrated knowledge representations.

1. Introduction

The next generation design systems will be developed in an user and network environment which force us to think along partially new paths. We will define meta models to ensure integration efficiency. Long-term research and more short-term activities must be coordinated and not treated as exclusive activities. The paper focuses on the relation between models representing user, product and process for the building application and IT-tools domains within an overall context description. The aim with the paper is to present a setting and hypotheses as a guide for the future development of Computer Aided Architectural Design Systems. A three level computer stored knowledge layering is presented and analyzed - the personal, company/project and global levels. The impact from evolving networked object systems, augmentation processes, publishing and access filtering is enlightened. A collaborative design scenario is presented influenced by new communication media and underlying integrated knowledge representations.

2. The Paradigm Shift

We are phasing a great paradigm shift which will influence our lives dramatically. We identify three important shifts (see figure 1)

- the art of writing (2500 b.c.)
- the art of printing (1400)
- the art of communication (2000)

We will encounter changes in many areas:
- ethics
- cultural communication
- environmental issues
- state of consciousness (shift to higher levels)
- democracy and decision process,
- organizational structures
- networked knowledge connections.

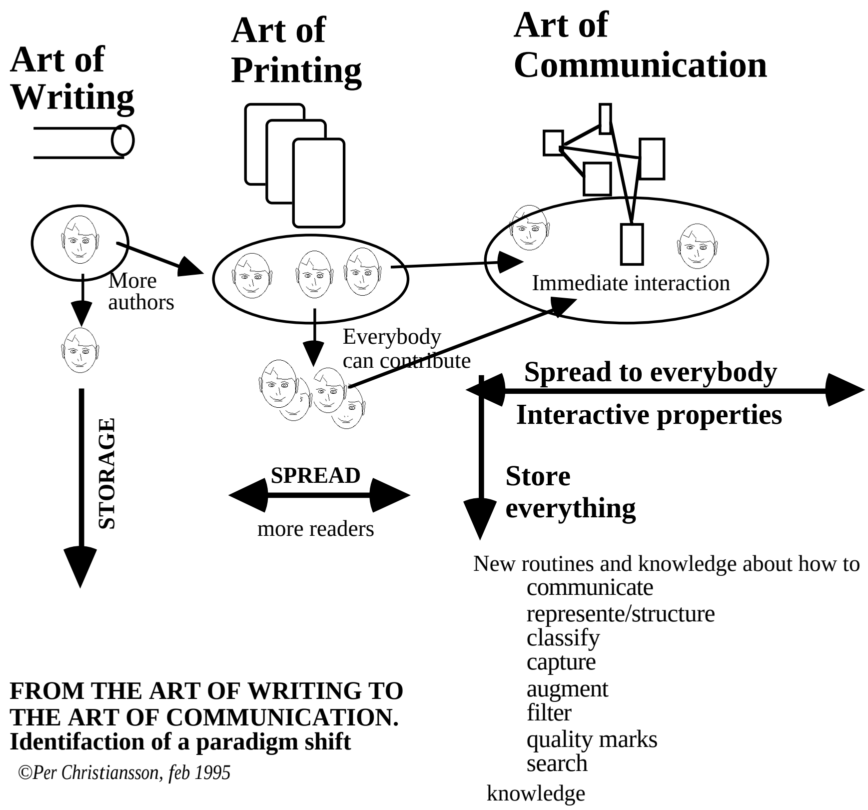


Figure 1 We are entering the third paradigm shift in historic time.

How can we *detect* the ongoing paradigm shift? from (Christiansson, 1995a):

"- the world is shrinking down to a global village,
- all computer stored knowledge is available (the knowledge is there somewhere),
- general sense of increased knowledge level and thereby increased consciousness level and increased AWARENESS in different undertakings,
- reduced knowledge duplication production, by for example global conferences in the world wide web,
- increased traveling (more interesting people to meet in real reality)
- obstacles, people defending positions and . "Puzzles that resist solution are seen as anomalies rather than falsifications of a paradigm". From page 92 'Theories and Structures: 2. Kuhn's Paradigms' in (Chalmers, 1978)." (See also figure 2)."

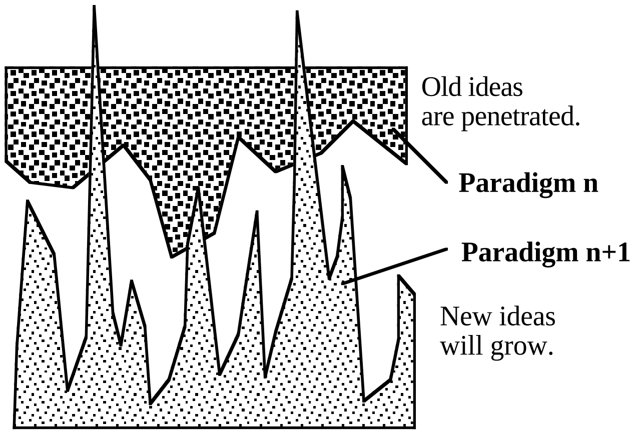


Figure 2 A new paradigm penetrates slowly due to human inability to massive un-learn. We must accept that a change process takes time. In a universal time scale this is not important at all. The most important thing is to be conscious about what is happening through an open mind.

We now need to take a holistic view in a very complex phase of changes. A top-down view must also be combined with a bottom-up approach. A *will* must be washed out which will help us set up our common goals for development. This requires intense life long knowledge transfer, open minds, and braveness. And in the long term a greater appreciation and utilization of peoples inherent different competences will develop. (See also figure 3).

For good and bad there are constraints on the speed of development. If it becomes to fast we cannot as human being assimilate it and consciously take part in the design of the future, see also figures 4, 5 and 6.

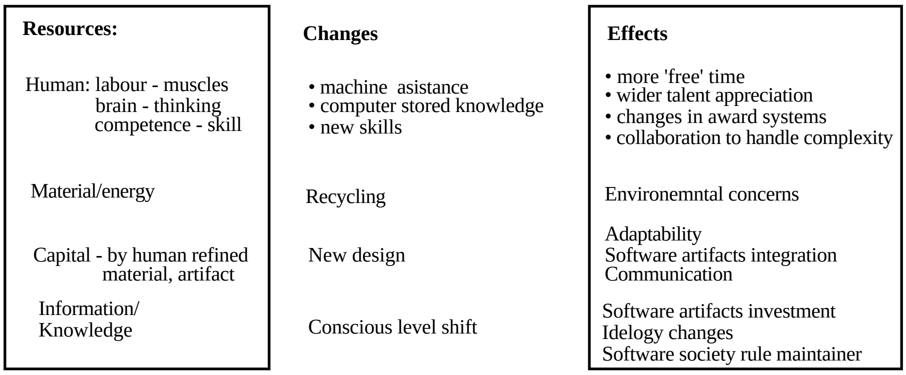


Figure 3 We must learn to better maintain the global resources. A wide spectrum of talents are overlooked. (Logics dominates). The problem now is to transfer free resources to something that supports the good life.

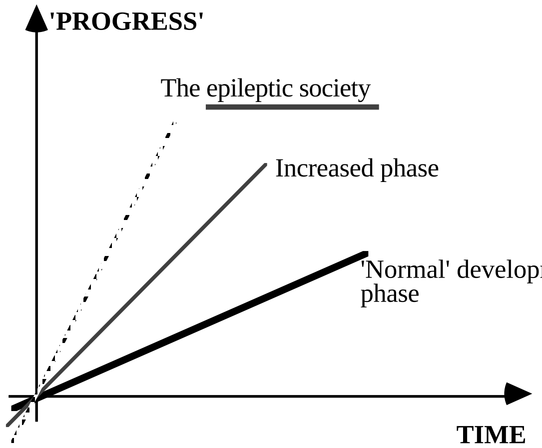


Figure 4 If development is accelerated above a level where we cannot conceive what is happening we have achieved the **epileptic society.**

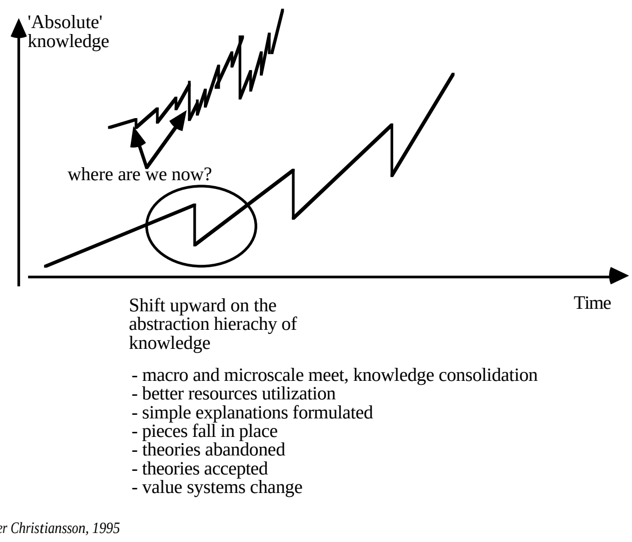


Figure 5 We can only guess about the future and to some extent about the past.

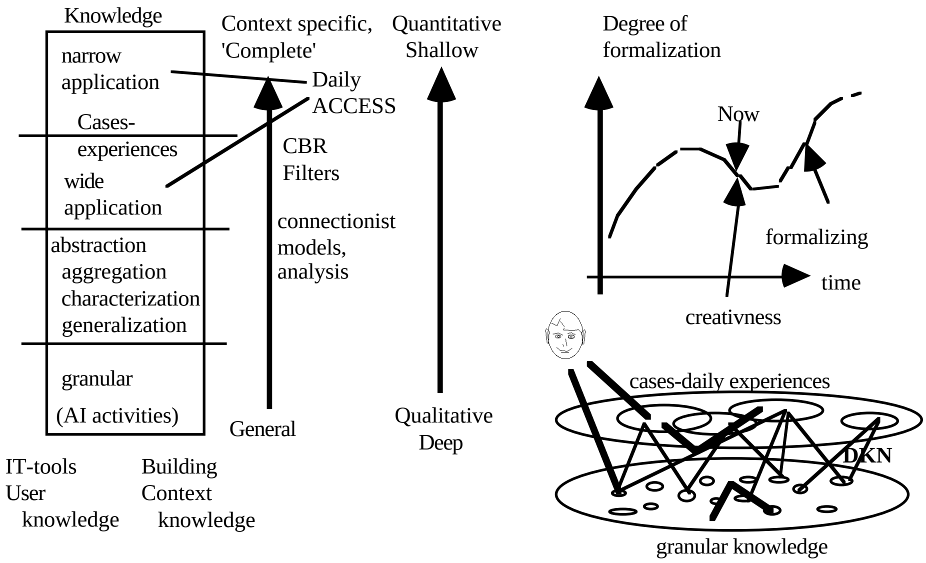


Figure 6 Knowledge described with regard to deepness, quality, and usability. It is also indicated that we are in a creative, de-formalizing phase of development contributing to the content of the deep knowledge containers. Formalization oscillations takes place on all knowledge abstraction levels with different frequencies. (Christiansson, 1995a). (The Dynamic Knowledge Net, DKN; is also visible in figure 9)

3. The Driving Forces

3.1 INTERNET

The development of Internet in itself and the access to powerful portable computers, is one of the greatest driving forces. In 1994 Internet hold 2.5 million computers (today over 7 million), 30 million connected persons, 35 thousand computer networks in 135 countries. The world wide web as an idea was created 1989, available during 1992/93 for global use. Today it is almost expected that you have your personal WWW-page on the web or at least research or company descriptions. We should not forget that Moore's law still is valid after 20 years (price/performance doubling on 18 months).

3.2 USER APPLICATION DEVELOPED. BENEFITS FOR THE USER

It is slowly *accepted* that IT is something more than an ordinary telephone system. We are in progress of integrating *all* computer stored knowledge and provide users with very adapted new tools and possibility to *participate* in the ongoing building process (e.g. for a designer or client to follow up design intentions).

SMR, Sentry Market Research, USA, predicted in mid 1994 a 150% increase in the systems supporting *work flow* at that point dominated by Lotus Notes. (Swedish Office of Science & Technology, May 24, 1994)

The CIMdata, USA, has measured an increase of the PDM, Product Data Management, by 36% during 1994. This is due to higher acceptance on company director levels. The PDM systems are being integrated with the work flow systems. (Swedish Office of Science & Technology, May 22, 1995)

3.3 THE GLOBAL VILLAGE DEVELOPED. NEW SERVICES AND RESOURCE FLOWS

If we want it or not the global village is developing with

- new business ideas
- cultural clashes
- improved understanding of cultural differences
- developing countries jumping over some unimportant development stages (few libraries in Vietnam, GSM telephones in the Baltics etc.)
- healthy global competition
- international projects

We will see an increased amount of trade actions on the fast growing Internet. Besides the bundled knowledge which will be for sale or subscription there will be one domain of free knowledge with different degrees of quality from filtered information in libraries to NN's stamp collection. See also figure 7.

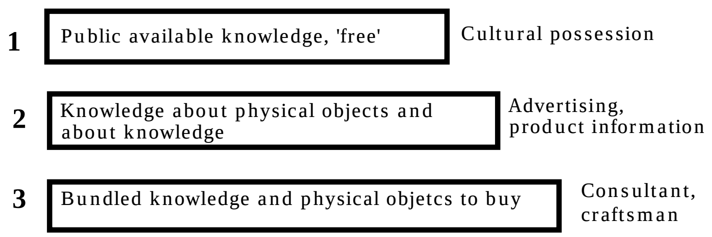
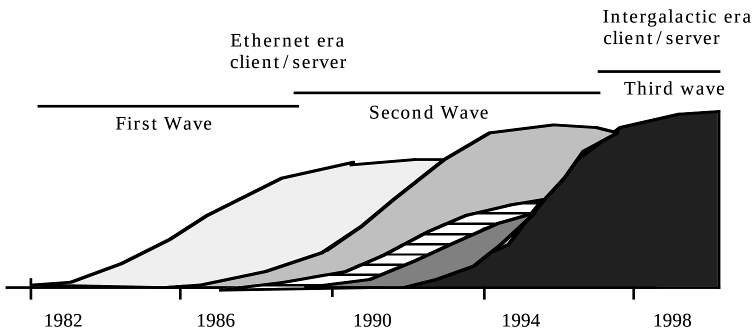


Figure 7 Knowledge as a trade item and a resource will increase. Software artifacts can be easily copied and distributed.

3.4 SOFTWARE REUSE (OBJECT ORIENTATION, MAINTENANCE, AGENTS)

The object oriented paradigm will help us in programming and maintaining the networked global operating systems, figure 8. We will be able to construct agents/knowbots which will help us to index information, filter, search, and collect information etc. International standards and agreements are developed in a much higher pace now at least on system levels. One example is the fast development of the HTML, hypertext markup language, commented on further below). This is though only the peaceful beginning of development of networked knowledge communication.



In the Ethernet client/server era, which is still very much in progress, SQL databases, TP (transaction processing) monitors, and groupware have begun to displace servers. But the intergalactic client/server era, with its distributed-object infrastructure, is fast approaching.

From Robert Orfali, Dan Harkey, and Jeri Edwards, "Intergalactic Client/Server Computing". BYTE April 1995, page 122.

Figure 8 "Intergalactic Client/Server Computing". (Orfali et.al., 1995)

4. Hypotheses concerning knowledge communication

The Dynamic Knowledge Net, DKN, which connects persons and computer stored knowledge will improve knowledge communication in many respects, see also (Christiansson, 1992) and (Christiansson, 1994):

- *improve collaboration* in and between project teams (problem identification, negotiation, interpretations communication, consensus reaching, casual explanation power, handling of nested complicated causal relations from personal actions in real *time* or in a slower non-real time interaction),
- facilitate and *filter* access to appropriate knowledge,
- provide a better *product specification* in an early stage of the design process (more complete high level description common for all participants, definition and detection of shared model parts),
- provide a *flexible* environment open for client/user requirements specifications and *creative* and *emergent* solutions,

- prolong the design team *participation* and follow up during the construction phase
- provide more complete, and *adapted 'documents'* for building operation, maintenance, and refurbishment
- provide a more powerful environment for *personal knowledge* augmentation and professional skills in a project,
- better handling of global *differentiated demands* from customers and building process participants (culture, life stiles, organization structures, hierarchies, and professional skills)
- provide efficient *feed-back* mechanisms from potential product interest groups,

through

- providing tools for *setting up* necessary design teams and project management routines
- improved user and *team models*
- *agent* communication (knowledge communication)
- automatic *conflict detection* in an analysis process (clashes in product, process, and user models)
- *conflict resolution* with user intervention
- etc.

5. Scenarios

5.1 THE DAILY ROUTINE WORK

In the daily work at KBS-Media Lab we have naturally integrated the Internet services. Every Thursday afternoon at 3 pm we meet in the electronic meeting room and have discussions on ongoing projects. Everybody can *plug in* their portable computer at the table and project on a screen at the table end. It is easy to reach and display information for the group - from your personal knowledge bank or any global knowledge container.

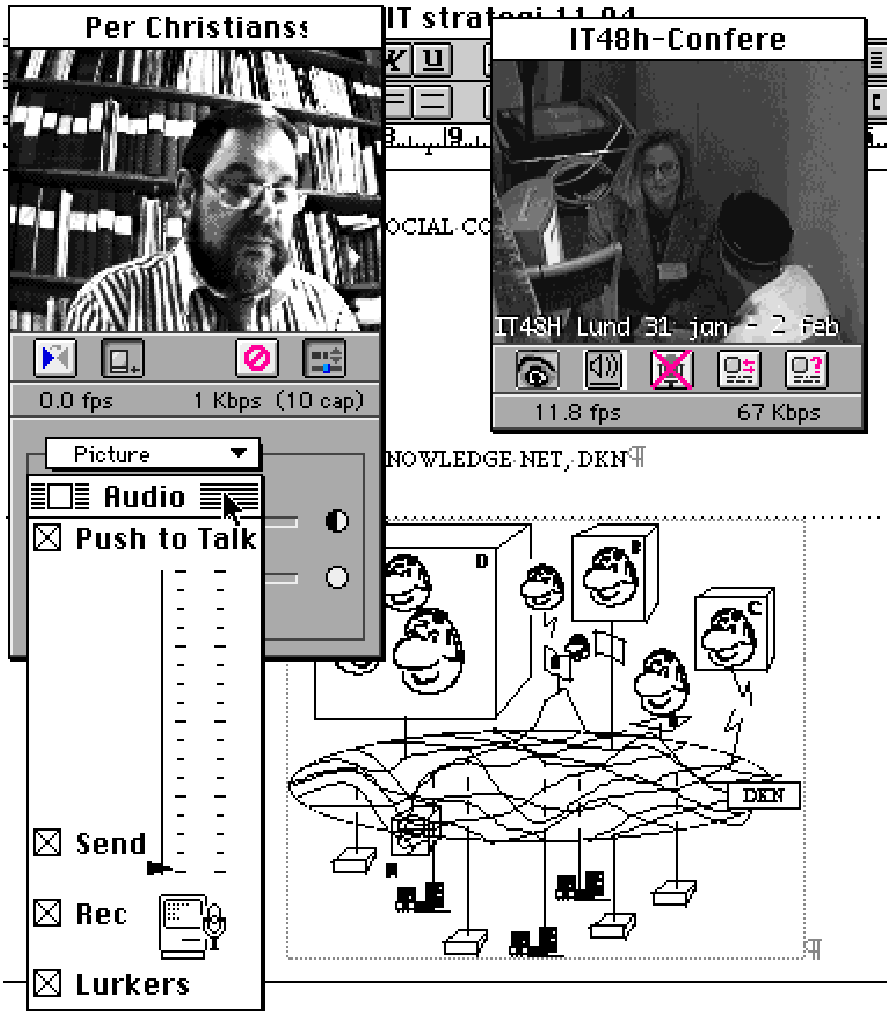


Figure 9 At the KBS-Media Lab we use digital communication extensively - email, WWW, news, video, and electronic meeting room. In the screen dump is also included our interpretation of the Dynamic Knowledge Net, DKN. See also(Christiansson, 1992).

Notes (text and figures) are taken and displayed for the group. At the end of the meeting the notes are emailed to the 'lab list' thus minimizing paper transport and eventual re-writing. We even send email from room to room instead of documenting our conversation on paper. Many project documents are made available on the WWW.

We have a *reflector* set up on a SUN computer which enables us to have video supported group meetings, see figure 9. Anybody in the world can join in on Thursday afternoon to our local meeting. The address is on our WWW HomePage.

The telephone can if you wish be controlled from your computer. We use headsets and thus have the *hands free* for taking notes and accessing the computer stored information during a telephone conversation.

We are not tied to the local Lab and University network outlets but we can connect to Internet through dialed up connections also on the GSM, Global System for Mobile Communication, telephone network. This works all over (with a few exceptions) Europe, Australia and South Africa.

95% of our previous paper communication is now on the Internet. We can also set up mechanisms to filter incoming email.

The communication environment is in itself a part of our research efforts to study the knowledge communication in different settings. We highly emphasize the importance of *personal meetings*.

5.2 COLLABORATION IN THE PROJECT TEAM

Translated from (Christiansson, 1995b) . "You have in the work group communicated via your personal computers with sound video on the Internet and have been able to work in real time on common documents. But the personal contacts cannot be replaced by electronic distant meetings. Thus you meet at N.N's place in her electronic meeting room. You bring your portable computers with you which are automatically linked to the net as you turn them on. You have access to your personal knowledge bank (notes, address register, letters, reports, etc.). You can at any time make your screen visible for the others on their portables *or* on the board at the table end. You pick up a drawing which you study and annotate together (you have your *personal icon* so you are easily recognized by the others on the screen). You though miss a fact that you know is contained on a WWW-server in Boston. You pick this document locally on your screen and show the others what you where thinking of.

During the meeting we had asked some key persons to be available as we might have to adjoin them to the meeting, the *'hinterland'*. We also contacted an office that was not on the Internet by using an ISDN connection and fetched some data we needed from a local database of theirs.

During the meeting you have also been appointed to take minutes. You do this on a document visible for the others. After each decision point you fix the content in consensus and at the end of the meeting each of you have the ratified notes in your personal knowledge bank.

During the meeting one of the activities was a *negotiation*. As an aid you picked up an IT-tool to support a structured discussion. As the discussion involved longer and more complex causal relations you had in front of you the discussion documented in graphical form with statements and the causal relations between them. In this way the decision *consensus* process became effective with conscious compromises achieved. You also *saved* the 'discussion' as a document reachable in later discussions."

The above described scenario was already reality in the first part of the COOCOM project (Modin, 1995) at the KBS-Media Lab finished summer 1994. The project was a joint industry project with the SKANSKA contractor, FFNS architects, LKF facility manager and residential house owner, and the Swedish Telecom (now Telia).

> From (Modin, 1995), "*The action-goal system*. Prestige is reduced by exchanging the time-dependent one-dimensional flow of oral speech with a two-dimensional graphical representation. The *idea* is that it is easier to give up on certain standpoints and reach consensus if you can see and point at parts of the line of reasoning. This method was explained to the working group by Robert Magnusson, who is a doctorate student at the department of applied psychology at Lund University. Robert also assisted at the simulations as one of the facilitators.
>
> The output of the action-goal-diagrams may be used for documentation of decisions taken. The diagrams does not only show what has been decided but also shows the *context* of the decision. In this way, at a decision point for re-building one can see what were the motives for the decisions taken: "They have chosen against forced ventilation because of the noise level, but they didn't mention anything about allergy, just about dust. Hmm, they probably didn't consider that." Below follows figures /only figure 10/ showing the action-goal diagrams that were produced during the simulations.

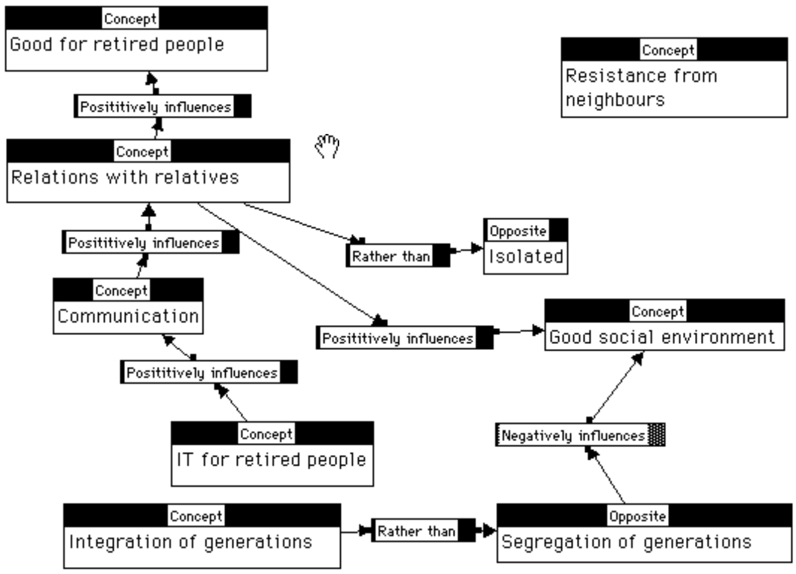


Figure 10 Action-goal diagram from a discussion on the grounds for building apartments for old, from the simulations. (Modin, 1995).

There are two types of objects, a *concept* and it's *psychological opposite*. A psychological opposite in this context means that you're not looking for the logical opposite (which is often just a negation of the defined concept) but something that qualifies the concept by being in conflict in it. This is expressed with the "rather than" relation. The two other relations in the figures are the "positively influences" and "negatively influences" relations. By linking Concept-opposite pairs with other pairs one builds up a network. In an elaborated network with all relations in place, concepts with out-going relations only are possible actions, and concepts with in-going relation only, are goals to be achieved or outcomes to be avoided."

The ICM prototype (Interdisciplinary Communication Medium). (Fruchter, 1995) enables a multi-disciplinary team to work on shared 3D graphic model. Interesting results are obtained from use of the system in *small scale* real settings. This type of projects are important to *demonstrate and reveal problems* and new concepts in connection with building up an integrated design environment. Contributions to a high level distributed conceptual model including classifications will come out as important results.

5.3 THE DECISION PROCESS

In (Bransford & Stein, 1984) the following steps are outlined to help you increase your awareness of the processes underlying problem solving - IDEAL (1) *identify* potential problems, (2) *define* and represent the problem, (3) *explore* a variety of possible strategies, (4) *act* on your ideas and strategies, and (5) *look* back and evaluate the effects of your action. If you combine this with (Norman, 1988) and his view on the problem solving process you get figure 11.

The introduction of advanced IT-tools will have significant impact on the decision process. In figure 11 some worlds are underlined pointing at actions which can easily be introduced:

- *problem identification* can be enhanced true computer stored experiences and idea generation
- *supporting facts* can easily be displayed/expressed in the early phases of the process
- needed resources and competence can be *composed* more flexible
- a rich *spectrum of methods and tools* to choose from. For example Case Based Reasoning to search and filter out (and adapt) old cases, (Kolodner, 1993), and (Gero & Maher, 1990) on modeling creativity
- a very *flexible problem solving process* which adapts to context also introducing a creative element,
- presentation of results and model manipulations in convenient form through *MultiMedia interfaces*.
- support of a *dialectic process* and recycling of the whole decision process

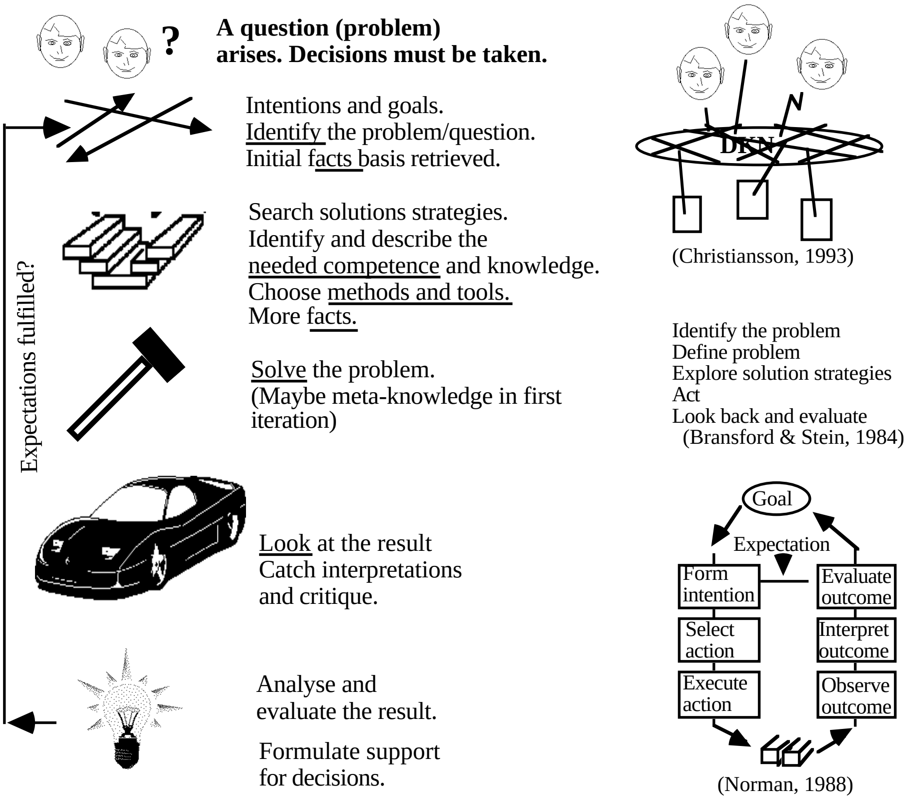


Figure 11 The problem solving process will be improved when it takes place in a Dynamic Knowledge Network environment. Improvements are - more adequate/right problems tackled, easier to interpret and evaluate results, better solutions, and more complex problem space possible.

6. Knowledge Structures and Domains

In figures 12 and 13 are given important concepts which can be used as we set up the future knowledge communication systems. The figure is commented on below.

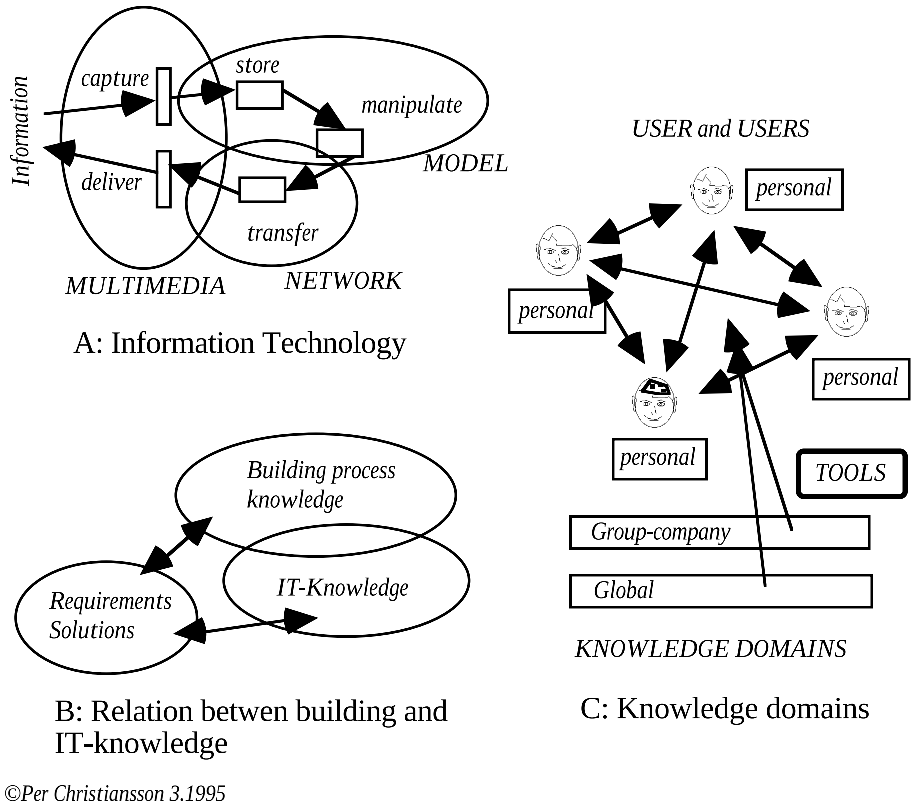


Figure 12 Important concepts when setting up models for knowledge communication. A: Information technology to handle computerized knowledge. B: Building- and IT-knowledge is impossible to separate when we design the future. C: Four general knowledge domains. (See also figure 13).

Translated from (Christiansson, 1995b). "Already today there are predecessors to the distributed object oriented system, CORBA, Common Object Request Broker Architecture, which is developed by some of the important market actors. We can today (using HotJava from SUN Microsystems) click on a WWW-page object which contains a geometric object of a for example a stool in a product catalogue. We can twist and turn the object using a another object which is picked from the net if it is not already in my client machine.

There must be structures, rules, and mechanisms developed within the building community to handle questions concerning:

- who owns the objects
- who is responsible for their functions?
- how can I reach a user wherever he/she is attached in the global network? (by the way we will probably in a few years have our personal smart-card which will give us access/identifies us/ to the DKN anywhere on the globe)

- how shall the objects be classified on a global basis?
- how can the systems learn and store context and user environments?

And above all how can and will I model my personal user environment in the new effective systems with regards to knowledge domains, languages, user interface, project/company organizations etc."

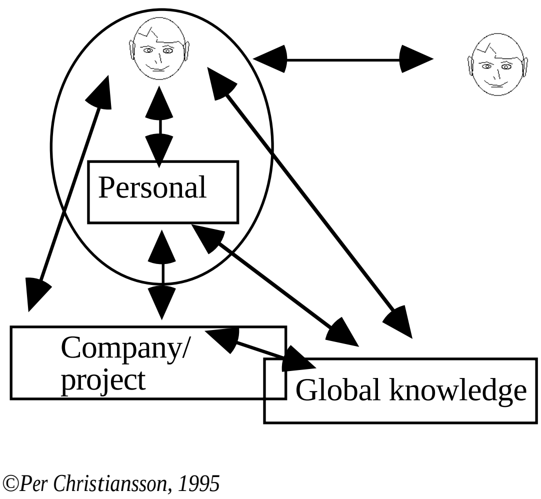


Figure 13 Knowledge on four levels that must be possible to integrate. (Christiansson, 1995b). (See also figure 19).

The hyper document of the WWW, can today also contain a 3 dimensional image specified in the VRML, Virtual Reality Markup Language, (Raggett, 1994). This means that we can include a rendered face model of a building and walk around it by pointing in the image. We will very soon have a very efficient platform for global object handling and access.

Hyper documents are now constructed as linked objects residing on separate disks in the global network. (Compare to the local environment in figure 14). This will of course raise a concern on the *security* on storage of such documents. During the creation phase (e.g. design work in progress) the concept is though very flexible.

Another concern is that a document that we also will have to deal with is the "virtual documents that only exists at the time you view them" (Reinhardt, 1994) (p93). In the WWW this is very convenient as you can create a special document which serves as a result or interaction medium for a users special needs. The generated information is though not direct available on a static HTML page.

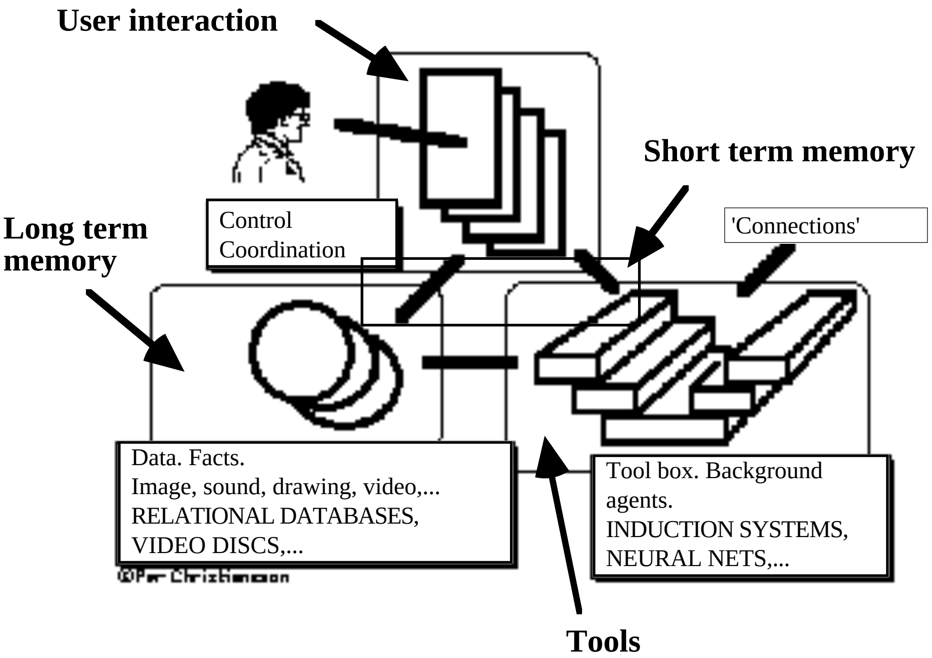


Figure 14 The original KBS-media concept from 1990 based on ideas on hyper documents presented in (Christiansson, 1988)

Figure 15 in another way shows that the border between the interaction models and the actual application models are not at all clear.

The application models represents a part of our reality. The models is reached through an interaction model with MultiMedia properties. The user interaction is significantly influenced by the interaction models introducing an instrumental effect (filter) on how we access (view) the underlying application models (and which models) and thus our interpretation of them. For example an analog image of a building can be changed by graphic tools manipulations and thus cause a change of our interpretation of the model of the building.

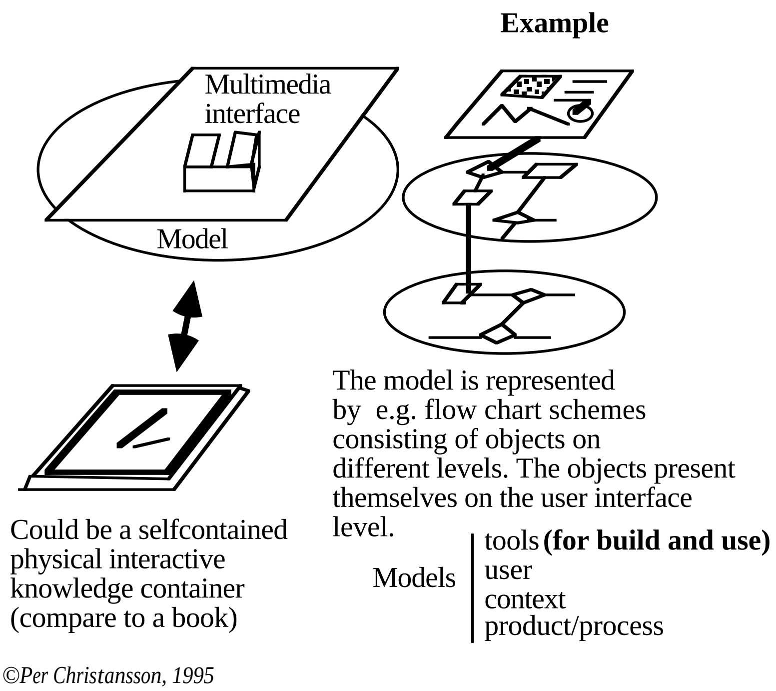


Figure 15 Part of the underlying computer stored model is incorporated in presentation and interaction models. The underlying models should be well reflected in the work space.

Outgoing from figure 14 and the above discussions on the object oriented global network we can expand the ideas and sketch a scenario as in figure 16. It raises some questions;

- where is public personal knowledge stored and for how long?
- what are the relations between physical and logical storage containers and who is responsible for knowledge maintenance?
- will there be standard objects for sale which can be used to dynamically create user adopted interfaces and to extract proper application knowledge from long term memory stores?
- what principles will develop concerning pricing of knowledge and which new forms for knowledge packaging will develop?
- how will knowledge be quality marked and which new mechanisms for knowledge brokerage will develop?

These and similar questions will get many answers dependent on which problem domains they originate from. Much analyses work is needed as well as evolutionary cross disciplinary creative work.

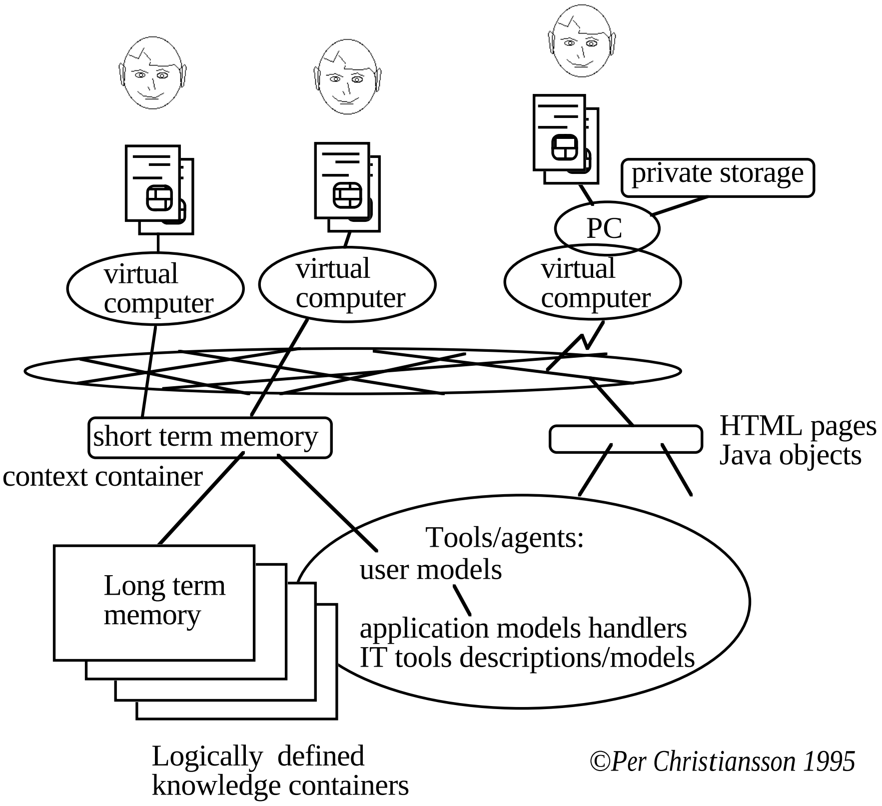


Figure 16 Adopted user interfaces with multimedia properties are contained in web-pages. These are in early stages of system design stored as explicit HTML pages. As forms and processes stabilize the long term memory is filled (relational databases, object stores, image banks etc.).

7. Models

7.1 ALL THE MODELS

The models we build up will support us in our communication activities. They will provide *storage* and *integration* potential for computer stored knowledge and support *communication* between the users of the models. See figure 17.

The models of our building applications should describe the models in terms as (with partly reference to Aristotle); see figure 18,

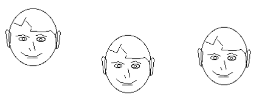
- form (macro scale)
- function and behavior (which is time dependent)
- content (attributes as material, color) (a micro scale of function)

The *IT-tools models* are necessary to formulate because the tools become more and more complex and flexible to different contexts (they actually are part of the context themselves). These models are probably easier to make general as they may be used in *many* different application domains and in general will support development and maintenance of computer systems on levels below special applications as building design and maintenance. We will of course get an IT-tool effect as all artifacts we construct do. Experience the introduction effects of for example, the wheel, telescope, steam engine, clock and computer. The user models are partly contained in the IT-tools models.

IT-tools could be implemented as agents waiting in the background to be triggered (automatically) or by the users in for example a select, drag and drop maneuver.

New *filtering* and *quality* marking processes will develop as we in parallel to a paper based one-way medium adopt the fully interactive global knowledge container.

Context



	STATIC	DYNAMIC Facet
MODELS	**Product**	**Process**
User	Agents	team work search analyses,...
IT	objects components agents,...	networking media, metaphores,...
'Application'	function form content	behaviour within and outside artifact

problem (requirements, resolution, abstraction levels, ...)
who participates (profession, interest, competence)
which product(s) are involved
which process(es) are involved

Figure 17 Outline of needed models to set up a 'complete' building process environment.

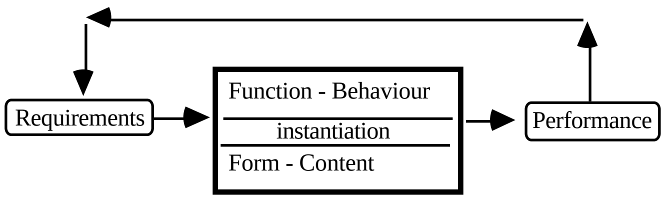


Figure 18 The relation between Requirements and Model Performance.

In the long run we will see the global network (the social nervous system), that we call the Dynamic Knowledge Net, DKN, be better and better understood. We will apply *impressions from many scientific domains*. As an example from

> (Feldman, 1989). "The extreme opposite models of neural representation lead to radically different views of many aspects of Cognitive Sciences. Table 1 presents a number of contrasting terms that arise, respectively, from the punctuate and fully distributed views of neural coding."

Contrasting terms	
Punctuate	diffuse
local	highly distributed
grandmother neuron	hologram, spin-glass
disjoint codes	homogenous codes
detector	filter
labeled line	pattern of activity
active memory	passive memory
reduction	emergence
hierarchy	complete connectivity
recruiting	adapting
general computation	correlation"

TABLE 1 Punctuate and fully distributed views of neural coding, from (Feldman, 1989). Applicable during design of the Dynamic Knowledge Net, DKN.

7.2 THE CONTEXT AND USER MODELS

The meaning of context is according to (Merriam Webster, 1993).

1. (1658) The part of a discourse that surround a word or passage and can throw light on it's meaning. **2**. The interrelated conditions in which something exists or occurs: Environment Setting.

Example on contexts may be:
- Architectural design
- Structural engineering
    - loading pattern
    - dynamic analysis, etc.
- Chemical analyses
- Socio-Cultural communication
- Simulation of heat transfer

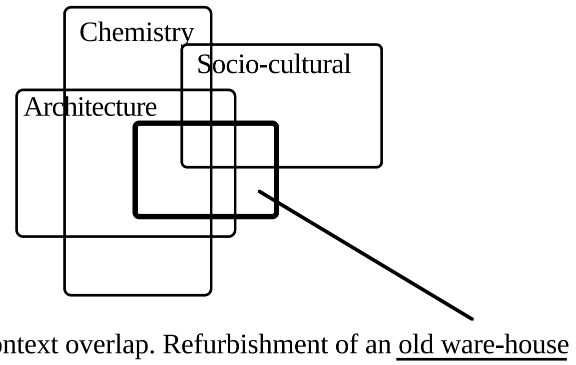


Figure 19 The context conceptual model is crucial to define when computer stored models are created.

The context provide us with a framework within which we can set up computerized problem solutions and *adjust* according to available resources (persons, tools, etc.). We may also use the context descriptions to climb between different problem domains through common models or sub models, see figure 19.

There is a debate today about expressing the cognitive models within our brains. A greater consideration of the *external* representations from context and persons in co-operation will be taken. This branch of cognitive science is called 'situated action', (Suchman, 1987), (Bickhard & Terveen, 1995). This is interesting as we model the relations between personal and project knowledge. How can we model the team, and it's knowledge communication in relation to the personal user model and knowledge storage? (see also figures 11-12)

In figure 20 is sketched the relation between internalized and externalized knowledge for the personal, project, and global levels.

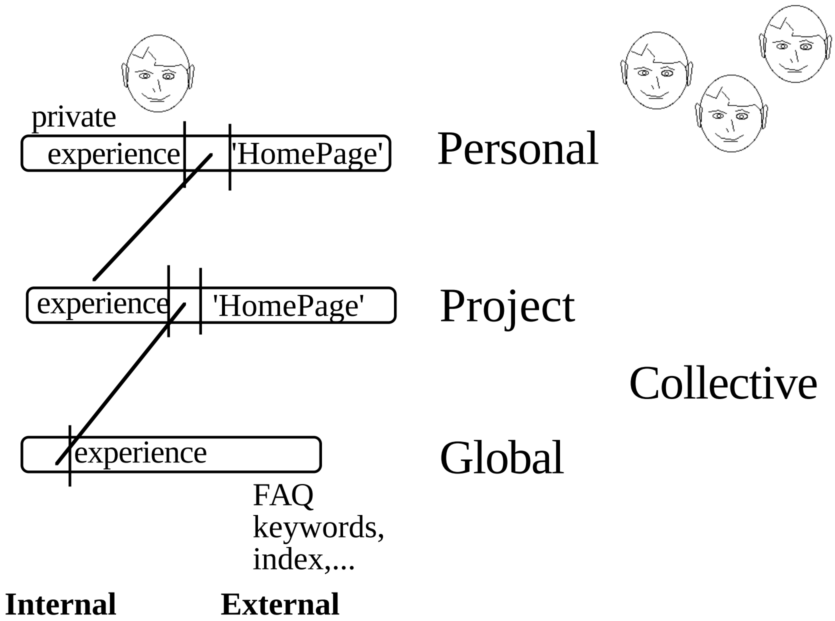


Figure 20 The relation between internalized and externalized knowledge for the personal, project, and global levels.

7.3 THE PRODUCT PROCESS MODELS

Figure 21 outlines a proposal for a general product model, which only has non-redundant properties on the highest level. It is probably not meaningful now to make or more detailed general model layout as the number of variations on overlapping underlying knowledge representations are very big.

It is though important to collect experiences from different environments and make them globally available and open for critique.

One denominator could be the vocabularies which will gradually develop. These can be used to reveal joint model properties implicitly.

In figure 21 the lower level models are furnished from the functional model to fit different groups in a design process. The annotation, version handling, and change propagation process must contain a lot of manual judgements (in a teamwork process). This process should though be carefully traced and evaluated against a more formalized and automatic constraint and change propagation process.

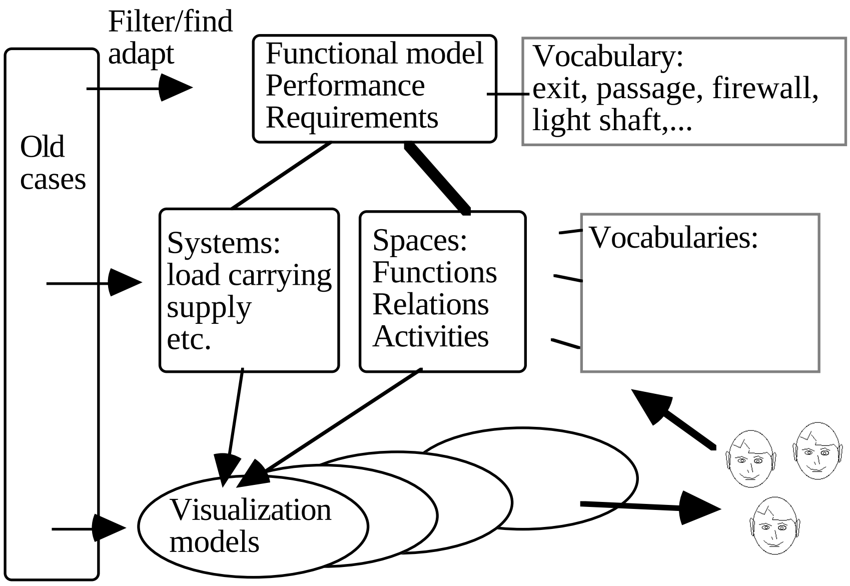


Figure 21 A proposed generic product model with non-redundant information only on the highest level. The traditional annotation and change propagation process should be traced and evaluated against a more formalized and possibly automatic constraints and change propagation process.

8. To build models

During new tools and artifacts development, tools that support the design process, it will be *very hard* to grasp the ideas if they are not visualized and exemplified in a demonstrator environment together with the end users of the systems. We use the demonstrator concept to capture, communicate, evaluate and implement new ideas continuously in a dialectic process with the end users if the system. In this way inventions and creative solutions to problems can be effectively generated, captured and tested in collaboration with the people most knowledgeable about the applications. See also figure 22.

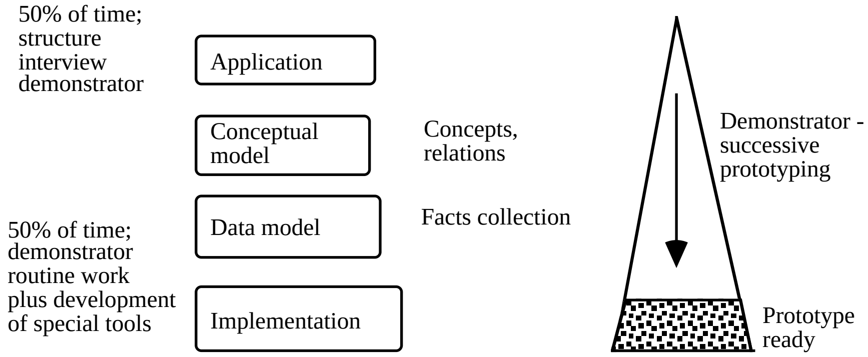


Figure 22 Effort input during systems development.

The feedback mechanisms on response to new products and project results will probably change in many ways due to the global network build up:

- immediate feed-back possible with less effort
- market interests should be easier to automatically track
- you can launch automatic news detectors that alerts you as something interesting is advertised.
- and so on

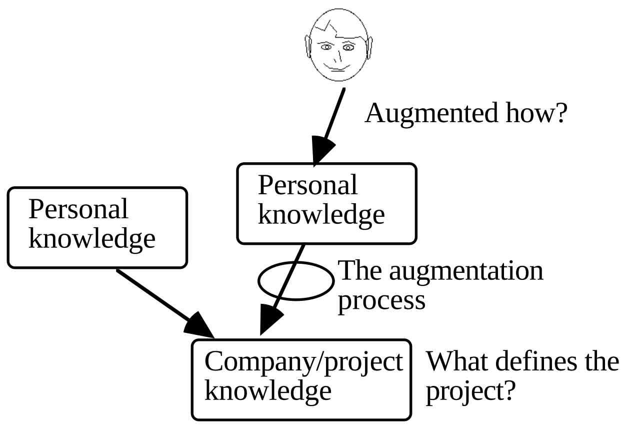


Figure 23 The systems should be prepared to incorporation of knowledge augmentation processes.

The systems should be prepared for the knowledge augmentation process on the personal, project/company, and global levels. This process can contain automatic procedures. Knowledge must not only encompass good problem solutions but also the ones we should avoid, see figure 23.

An example of a system to collect problems and their solutions at a building site is described in (Christiansson, Modin, 1994). The system contains company specific knowledge which is stored as question-answer pairs on three levels - (1) one answer, (2) alternative answers, (3) learn more about the basic facts. The system has a MultiMedia interface.

We are at the KBS-Media Lab designing and theoretically and practically analyzing an neural net based agent which will help the users in their task of achieving relevant information in the large WWW knowledge network. The agent does most of the time consuming work, in the same way that the user would do it, and then presents the answers to him/her.

We are also designing and constructing (summer 1995) a knowledge container-communication node, SWEBU, for the Swedish Building Research Council. The WWW server will contain and point to research project foundations, status end results as well as advanced tools for search and communication.

9. Recommendations

At the talk the following recommendations were given:

- support knowledge transfer with continuos evaluation and critique
- closer links between research and industry
- support explorative research and mix of scientific disciplines
- benefit from personal experiences from knowledgeable persons
- use the World Wide Web for knowledge communication
- more R&D on team modelling and behavior

10. Postscript

This paper was produced to deliver a setting, ideas and hypotheses as a guide for the future development and discussion of Computer Aided Architectural Design Systems. We must in the future face a rich spectrum of systems solutions which can and should be evaluated and critiqued in a global context. Inspiration comes from our work at the KBS-Media Lab within the area of knowledge communication in the evolving global networks.

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