The Design of a Basic CSCW Environment The Collaborative Desktop Experience

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Abstract: From an analysis of co-operative work as a collaborative process in an information society we state requirements that a CSCW environment should meet. From these we have designed CoDesk, the Collaborative Desktop, a basic environment for CSCW that in its original form looks rather mundane but has the potential to be used both as building blocks for specific CSCW environments and as a fundament for new CSCW systems and applications. CoDesk has been designed in an iterative prototyping process, which is described and evaluated. How new interaction styles can be used in a CSCW environment is presented and analysed.

Introduction

In this paper we describe our design of a basic environment for CSCW. We start with a discussion of a general framework for CSCW which leads to some basic design implications. In a further elaboration on this design we review some earlier CSCW system to pull out some guidelines for a more detailed design, which has been accomplished using user-centred design methods with mock-ups and prototypes.

In several papers and demonstrations we have presented different aspects of the work with the Collaborative Desktop: the environment in (Marmolin, Sundblad and Tollmar 1994), the KnowledgeNet in (Marmolin 1991), the use of the space (room) metaphor in (Marmolin COMIC 1993), the use of shared objects (Sundblad COMIC 1993) and (Tollmar COMIC 1994), the graphic interface in (Tollmar, Sundblad 1995). The current paper summarises the CoDesk experience with special emphasis on the design process.

A general assumptions in our work is that a basic environment for CSCW has to have the following characteristics both of which few CSCW systems so far have taken into consideration.

- Bridge the gap between the single-user systems that are used today and CSCW system(s) by providing an environment that merges rather than separates today's tasks with co-operative tasks.
- Support information sharing as well as communication via different media

Some basic characteristics of CSCW

In this chapter we give a general background for our design. We follow two separate tracks that will merge to a set of requirements for a CSCW environment. In the first track we make an analysis of the collaborative process from some social and technical viewpoints. In the second track we focus on the information society in general and find that many of its demands are similar to requirements on the collaborative process.

Collaborative processes

An important aspect of collaboration is that it is a social process, controlled by social conventions as Kraut et al (1986) conclude from their study. They interviewed 50 research teams and concluded that the most important aspect of collaboration was the establishment and maintaining of personal relationships. These are the glue that holds together the pieces of collaborative efforts, but also the source of many problems in collaboration. Kraut et al point at the importance of geographical proximity for the development of personal relations in general and especially for the development of trust, which is crucial for collaborative work. Also Harrison et al (1990) emphasise that social processes constitute the basis for all the negotiations, commitments and responsibilities that control the work process.

In the view of work as a social process the need for support of informal personal networks become clear, especially in work environments where the boundaries between work, knowledge achievement, information gathering and pleasure are not very distinct.

Another important aspect of collaboration is that it is a communicative process. For example, Johnson (1989) views collaboration as a communication process and argues that the characteristics of human collaboration can be abstracted from examinations of conversations, especially from breakdowns in conversations. In a distributed environment collaboration has to be accomplished by communication.

As found by Kedziersky (1988) questions to other designers are an important way of sharing information. However, as pointed out by Curtis et al (1988), documentation is not enough and a useful knowledge base also has to contain information about "who knows what", that could be used, e.g., to suggest who to communicate with.

Collaboration could also be viewed as a process of knowledge integration. Integration of knowledge and experience among team members is obtained by collaborative idea generation through discussions and brain storming, by reviewing, annotating and critiquing work etc. In an ordinary environment, new ideas are created, developed and tested in mainly informal situations.

Kraut et al´s study (1986) also points to that the preferred work strategy in collaborative work is to avoid working together unless absolutely needed, i.e. to keep what we call the *collaboration load* as low as possible.

Collaborative aspects of work seldom concern work execution. However, a lot of groupware, as tools for co-authoring, co-editing, co-drawing (see e.g. Beaudouin-Lafon 1990) are built on the assumption that people really want to accomplish tasks together. A more plausible assumption could be that information sharing is at least as important for collaboration as to work together on the same task. This could at least be true for professional routine tasks such as authoring, coding, drawing etc., although it may not hold for highly creative tasks such as problem solving.

A strategy of division of labour for keeping the collaboration load low leads naturally to consideration of collaboration as a management activity including planning,

monitoring, negotiation, scheduling and decision making. Planning is concerned with the co-ordination of the activities to be performed, which often involves negotiations about commitments. Monitoring concerns decisions about how to achieve the goals.

Another important component of a collaborative process, e.g. identified in several papers from the Esprit COMIC project (1993 & 1994) is the awareness of the actions of and changes in activity status of other members of the collaboration team and of changes in the shared work material. Mechanisms for supporting awareness are thus very important in CSCW systems.

Information society

One important need in modern work life is efficient handling of information in a society that produces so much information that traditional text-based and TV-based media are insufficient. The need to handle the "information overflow" has been characterised as a change in the social paradigm of society (Kumon S., 1992) and different visionary computer based solutions have been suggested (Bullen and Bennett, 1990) and (Engelbart 1990). These solutions are all focused on the management of published information in global and open but personalised libraries.

Different forms of free "work", knowledge work, design and software engineering, become more and more common in several work settings (Kling & Iacono 1985). An other way to interpret Kedziersky (1988) is that rather than by excessive reading of documents the information overload is often handled by using other people as references.

According to Morgan (1986) people in organisations always form informal networks. These "occupational communities" cut through the organisation and may provide the members with opportunities for identification and forming of reference groups, not only within the organisation but also outside (Gregory, 1983). In teamwork a member both improves his or her professional skills and gets an opportunity to extend the personal networks.

New friends are often made by chance, for example two persons sit near each other during a meeting. But these informal networks will develop not only by chance but also through the abilities of the people involved, they could include people from e.g. the work-team, friends from school and the company's basketball-club.

Garsten's doctoral thesis, based on a field work at three different Apple sites shows that the Apple employee is encouraged to work on the personal networks explicitly as well as implicitly (Garsten, 1994). Explicit encouragement is given in the introduction course for newcomers. They are told to search for the information they need to manage their work tasks by themselves and doing it by networking since the apparently not bureaucratic organisation has limited routines to distribute important information. The implicit encouragement comes from the general insight that big informal networks are the best start on a good career. The company president asks an employee about the importance of a wide personal network (Sculley, 1987) and gets the answer "Because that is the natural course of how ideas flow".

(CSC)Work Environments

Our discussion can be summarised in terms of a set of general requirements that a CSCW environment should support:

- Integration of today's work and tools
- Division of tasks
- Informal personal networks
- Communication in different media
- Sharing and record keeping of information
- Strategies for sharing of background knowledge
- Awareness of interesting changes

Before we in more detail describe the Collaborative Desktop environment we introduce some basic models and metaphors that can be used to support the requirements above. These models and metaphors are the basic work environment, the KnowledgeNet and the tool approach.

Environments for CSCW

In the still new art of design of CSCW systems most of us look for general overall solutions. Here we first examine earlier work that has tried to capture the "nature of work" and argue why we think that many of those models lack realism and are more or less useless in real work situations, and then give as an alternative our approach.

Many models for CSCW tend to be goal oriented. Most include some conception of an activity that has some goal. The more specific the support, the more specialised and narrow the goals. Trevor, Rodden and Blair (1993) have classified the different models for co-operation into three classes: procedural models, activity models and frameworks.

With procedural models one tries to model and capture procedures that are intended to happen while performing a certain task in, e.g., an office environment. Examples of these kind of system are the Coordinator (Medina-Mora et al. 1992) and DOMINO (Kreifelts et al. 1991).

To give more flexibility activity models have been introduced, for example the Amigo Activity Model (Danielson 1986). Activity models focus on what and how the work is done to describe cooperative work more effectively and non-statically.

Trevor (1993) argue that Frameworks are "the most general form of cooperative environment" and are intended to go one step further than activity models by focusing on the co-ordination of activities in groups or teams without a specific application or domain in mind.

In reality, work is not well structured or defined. People do the unexpected more often than the planned (see e.g. Suchman 1983) to achieve a task. Robinson (1993) has in his research argued the importance of use common artifacts to understand and be able to support a multidimensional world of activities. Several systems focus on co-ordination, while co-operation in work is often mediated through the material, the documents or the notes. A model of co-operation based on messages seems too one-sided and unbalanced; co-operation based on sharing seems equally important.

We therefore wish to add another class of CSCW models to the previous list, basic work environments. In such an environment, users could in a mundane way find support for CSCW within different mechanisms and tools used today. One natural part of this environment is the building blocks that are needed to be able to "live" in the environment, to extend and rebuild it. Another natural part is to provide some basic mechanisms to enable the integration of different communication mediums like mail and video conference tools.

The KnowledgeNet Vision

In The KnowledgeNet we view collaboration as the sharing and integration of knowledge and regard many other collaborative activities as means of accomplishing this aim. With The KnowledgeNet we aim at supporting this process by shared knowledge bases of experts accessible by CSCW tools. From a visionary perspective The KnowledgeNet is an attempt to make undocumented knowledge public in the same way as libraries make documented knowledge public. The KnowledgeNet could thus be viewed as a distributed "library" of documented and undocumented knowledge that is made accessible by CSCW technology.

According to Schmidt and Bannon (1992) CSCW should be conceived as an endeavour to understand the nature and requirements of cooperative work and contribute to the conceptualisation of work with the objective of designing computer based technologies for cooperative work arrangements. The KnowledgeNet could be defined as

the infrastructure of personal relations that knowledge workers develop in order to get access to information of importance for their work. It serves as a common information space that fulfils the requirements of a cooperative work arrangement specified by Schmidt and Bannon (1992).

Multiple Nets

People often belong to more than one net, both larger nets distributed geographically and small nets located in the same work place, sometimes embedded into the larger nets. These nets are characterised by some kind of social rules that define identifiable groups and secure the exchange of information. Although the groups are rather persistent, they are dynamic and memberships and objectives will change with the needs and constraints of the situation. Co-operation in these groups is often informal, controlled by social conventions rather than formal rules. Members are mutually dependent and they are active as long as they have some benefits or as long as the net supports the job to be done. However, the job to be done is often an individual job, as writing an article, solving a design problem or finding some facts to be taught, and cooperative work is combined with individual work in an indistinguishable way. Collaboration in such nets is both synchronous and asynchronous and there is both face-to-face co-operation and co-operation mediated by different tools.

Peopled information space.

Schmidt and Bannon (1992) point out that a common understanding of the meaning of the information is as fundamental as the sharing of information objects. For efficient collaboration a common information space has to be jointly constructed and negotiated by the actors involved. The information space has to be "peopled". A common information space must be "peopled" by actors who are responsible for the information in the system. Schmidt and Bannon raise the issues of supporting the identifying of the originator of the information, the context of information and the politics of information. Thus, The KnowledgeNet should support access to and communication with the one responsible for the information as well as the sharing of information objects. Support for the construction of a conceptual reference of frame for interpretation of the knowledge and the political goals of distributing the information are other important requirements.

Social awareness.

With social awareness we mean awareness about the social situation of the members, i.e. awareness about what they are doing, who they are talking with, and if they can be disturbed by questions etc. Many researchers have pointed out the fundamental importance of social awareness. Gaver (1992) uses the term affordance to characterise the physical properties of media space that provide such information. Moran & Anderson (1990) and Gaver et al (1992) discuss these problems in terms of peripheral awareness. They point out the importance of signalling the availability of information and people in a way that uses the human capability to peripherally process not-attended parts. Dourish and Bellotti (1992) point at the danger of introducing awareness mechanisms that are not controlled by the users and argue for passive mechanisms. Robinson (1993) discusses the importance of the multifunctional character of artefacts for collaboration and points out that they among other things should help people see at a glance what others are doing. Many researchers (see e.g. Johansen 1989) have found that informal collaboration is a fundamental aspect of any CSCW environment, and awareness of the social situation is needed for such collaboration. Kraut et al (1986) have showed that geographical proximity is fundamental for the development of personal relations and communication and geographical proximity provides much better social awareness. All these results indicate that social awareness is a fundamental feature of effective collaboration in a knowledge net.

The KnowledgeNet has to provide such social awareness. The KnowledgeNet should not only facilitate task accomplishment but also support communication of social

behaviour patterns, establishment and development of personal relations and spontaneous drop-in meetings (Marmolin et al 1991a). That is, The KnowledgeNet should be multifunctional and support both social goals and job related goals, both informal and more formal collaboration. To meet this requirement The KnowledgeNet should support the users perceiving other users as close to themselves and provide information about the activities and status of other users.

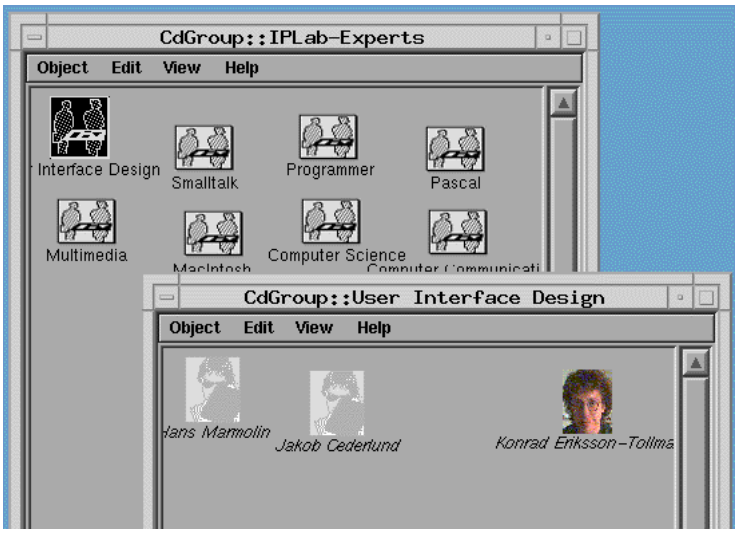


Figure 1 - Users knowledge forms competence groups

Our environment strives to support the KnowledgeNet vision by providing all users with tools for a seamless integration of synchronous and asynchronous modes of interaction, for example by enabling social ad-hoc communication and allowing the user to toggle between activities as in real life. We think that one can use CoDesk both to talk and work as a complement of more formal and planned work processes.

Tool Approach

Instead of designing groupware based on analysis of a specific design task or collaboration task to be fulfilled, we propose, like other researchers e.g. Moran and Anderson (1990), Bannon and Robinson (1991), the design of generic collaborative tools. The user chooses in the “tool-box“ and applies single tools or combination of tools in the order and manner she or he finds appropriate to perform the task at hand.

The tool-oriented approach aims at designing a user controlled environment that makes it easier for the users to do what they want, without limitations and assumptions imposed by the system. As other researchers suggest (Greenberg 1991) user control is a key factor for usability, and this is certainly also true for our work environment. An obvious advantage with the tool-approach are that it enables the use of most of today’s single-user tools for co-operative tasks.

Usually the tool perspective focuses on individual use that one might find contradictory to co-operative work. With a tool-oriented approach the users can apply and develop individual and original skills that will form the core as the basic resource in co-operative work teams.

The Collaborative Desktop as an Environment for CSCW

The Collaborative Desktop (CoDesk) is an attempt to make collaboration a natural part of the daily use of a computer. Our way to achieve this is to put the user in the centre of the

computing in a similar way that applications and documents are defined and visualised in the desktop metaphor.

We have developed CoDesk from something that we know works: the desktop metaphor that has made daily computing a lot easier and more error tolerant.

FIGURE 2 - Drag and drop operations in the GUI.

CoDesk is a basic environment for CSCW. We have extended the traditional desktop metaphor with a few new objects that enable co-operative work. Without being limited to a specific model of co-operation, each user can tailor or form the desktop to individual needs for co-operation and communication. In CoDesk it should be as easy to look for your colleagues as for shared or individual working material. Central in CoDesk is support for groups or teams to form co-operative settings.

Primarily CoDesk provides mechanisms that extend the network from a computer network to a user network by integrating the essence of communication and collaboration via different tools and media.

Basic CoDesk Objects

Members, groups and rooms

The most central type of object in CoDesk is the individual person, known as a member, represented both as icons and as forms (e.g. “cards“) with attributes, including name, communication lists and KnowledgeNet who-knows-what information. Groups are simple collections of members. Each member is connected to a key group that can be viewed as a member’s default group.

Figure 3. Extended User Information with KnowledgeNet Data and access to direct communication.

We, just as other researchers (se e.g. Borning 1991), have chosen a room metaphor, (Marmolin COMIC 93), where rooms are used to represent a collaborating group or a

specific meeting situation. The rooms are additions to the groups and should been seen as dynamic co-operative settings. Rooms are familiar environments for co-operation and work. Rooms are where you meet people, do your work, read a paper etc. For movement and navigation in the rooms the desktop metaphor is used through pictorial representation, the graphical user interface, and search-and-retrieve tools. Note that rooms are not only for sharing but also for individual use like a private mail list.

We also explore the role of rooms in supporting “social browsing“, as Root (1988) used in Cruiser, by “group awareness“ mechanisms. The user can set allowed “disturbance level“ of group members, in the same room or making a “random walk“ visiting a couple of rooms. The most common way to communicate with some members will be to install a common room with some tools and working material, e.g. documents, specific to that group. To support temporary connections with other group members a temporary room could automatically be installed by, for example, a direct phone call to an user.

Documents, tools and folders

As found by Reder and Schwab (1990) work behaviour is characterised by multitasking, and many activities and interactions are structured into communication chains that criss-cross each other. This means that tools for collaboration should allow and support many collaborative activities at the same time. A user can jump from one activity to another, have “sleeping“ activities that will be continued later on, and so on. The ability to adopt different kinds of tools has been argued by Grudin (1988) to be a main key in successful CSCW systems and has therefore also been one of our major goals. We believe that our architecture makes it possible to integrate and use a large amount of ordinary single user tools into the Collaborative Desktop.

Common tasks for which collaboration through computers is particularly suitable are writing text, designing graphics, sound or video together. Here the collaboration is mediated through the “material“ we work with. To design CSCW system from the viewpoint of a common information space could be very valuable and useful (Bannon and Schmidt 1992).

As discussed above in our generic tool approach another method to extend the Collaborative Desktop is to provide new tools.

The folder object gives a simple and convenient container for sorting and organising documents.

Figure 4. CoDesk - An environment for CSCW.

Building, Using and Extending the Collaborative Desktop

CSCW systems based on “a shared information space“ have gained growing attention. Such systems are attractive as both time and location independent but they need to be augmented by direct user communication.

In an environment like CoDesk “a shared information space“ is built through the use of it. There is no feasible way to pre-fabricate such an information space. As argued by Hendersen & Kyng (1991) we strongly believe that the initial design of the system will be re-designed during the use of it. Of course this does not decrease the demands on the initial design. It is essential both to be able to relate to and use “old“ information generated through the use and provide a more formal information space that reflect the organisation where it is used.

Iterative Design of The Collaborative Desktop

Such traditional formalised design procedures as top-down decomposition have a generic in-built error in that people mostly do not follow them very closely. Instead designers, individual or in groups, tends to design and work serendipitously (Krasner and Curtis 1987) or opportunistically (Olson & Olson 1991). As a matter of fact these deviations seem to be essential for producing quality design, especially in new technology.

Our general design might be labelled holistic as it is described in (Preece et. al. 1994). It has not been directed towards a specific category of users but towards presenting our ideas, design and conceptual model in different contexts to a rather large spectrum of possible users.

A strong focus has from the very beginning been to show the visual appearance of the interface and the model in our prototypes. This has allowed us as designers to use our creativity rather than constrained us into structures of representations. Clearly this form of design does not fit into all kinds of development, but for the design of the CoDesk system it has helped us out of the constraints in more structured design methodologies.

We have used several different techniques in the design of the Collaborative Desktop including HyperCard prototypes, live demos, videos, paper mock-ups as well as, naturally, academic studies of earlier work. This section will go through some of our experience and results for the design of the collaborative desktop using the different design techniques.

The designs in the different techniques have been tested with task walk through but a fully realistic user testing, giving feed-back and evaluation for the full prototype Unix system still remains to be done.

HyperCard Prototypes

The choice of HyperCard, or SuperCard - that we also used, to create prototypes was maybe one of the easiest in our design process. With HyperCard we can very quickly create a dynamic visual representation of some ideas. As argued in the design of the Designers Notepad (Twidale et al. 1993) it is essential to start without any “hard“ theories of CSCW environments but rather have the goal to find some requirements by observation of users.

The Extended Desktop

We started by designing an environment based on an office metaphor, like the prototype in figure 4. By making it self-contained we got a system that was possible to use rather independently of the context. After some iterations with different prototypes that more looked like communication tools than generic environments we started to play with a direct manipulative interface.

Handling objects that are per definition interactive lead our metaphors to become more abstract and more generic. This made us figure out a solution that is based on a generic extension of “something“ rather than a complete new environment. Inspired by Henderson (1987) we integrated the room metaphor, among some other objects, into an extended desktop. This design fits well into our initial requirement that an essential factor for acceptability is to support an environment that bridges the gap between the systems that are used today for single-user work and the new co-operative system(s).

New Classes Of Objects In The Extended Desktop

As described above our new objects are: users, groups and rooms. To simplify the use and understanding of these different kinds of objects we worked out a relationship between the new CoDesk objects and the traditional desktop objects in graphic interfaces such as the Macintosh (Apple 1992) and Motif (OSF 1989). This means in our CoDesk system that the syntax and semantics of how to perform direct manipulative operations on CoDesk objects could be predicted by the normal behaviour of single-user graphic interface objects:

- Users represent (informal) knowledge and competence, just as documents represent formal knowledge.
- Groups are used to form groups of users, as folders are used to organise documents.
- Rooms provide a means of creating and using cooperative settings - to get in contact with users, just as tools are used to get a visual appearance of different forms of documents.

We have tried to further visualise these similarities in the graphical layout of these objects’ icons. In (Marcus 1982) we find guidelines for icon design based on the cognitive impact which we have used:

- A vertical rectangle, one by square root of 2, for stable objects - users and documents
- A horizontal golden rectangle for permanence - the groups and folders
- A diamond for movement and tension - the tools and the rooms

As mentioned earlier an important part in supporting cooperative work is to handle shared working resources. We soon realised in the study of our prototype that we need to visually represent cooperative awareness of shared objects. This cooperative awareness, or “social browsing“ as Fish et al. labelled it (1990) can be provided in the graphical user interface by different forms of visual addition to objects, see figure 5. So far we have defined four forms of awareness:

- Active, an active object indicates that it is used, a user that has logged in or a document is used by someone
- Notify, which provides a mechanism to trigger colleague's attention to certain objects.
- Watched, trigger your attention to changes in a certain objects, e.g. to wait until a user has logged in
- Passive, a notified object expires after a certain time and become a passive object - that is the default awareness mode.

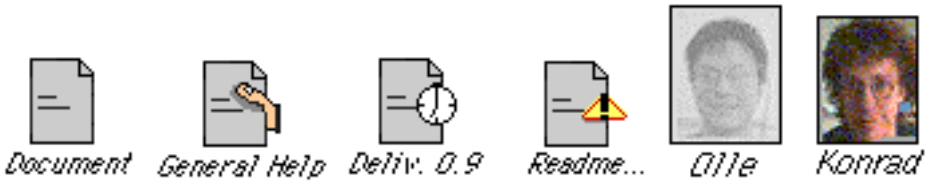


Figure 5. Visual co-operative awareness.

Summary on the HyperCard prototypes

We have made two kinds of HyperCard prototypes, horizontal and vertical prototypes. The horizontal prototypes are “broad“ and concern overall look and feel. The vertical prototypes are “deep“ and concern specific tools. Combining vertical and horizontal prototyping is a promising technique for system design but as Kensing (1993) argues it might be far from sufficient. Attention needs also to be focused on other aspects of the system design.

A “Semi-Working“ Prototype and Live demos

The above mentioned “other aspects of the system design“ are very hard to point out directly. Lack in communication, lack in understanding are normal problems in design of computer system. For CSCW systems these aspects are especially important as they are in themselves based on communication and understanding of social processes.

To learn more about the design problems we took as a natural next step after the HyperCard prototypes to build a working prototype that can scale up to more extensive use. We used a Unix based environment on multimedia workstations, rather expensive but off-the-shelf products - but not until today really scaleable.

The software used for handling distribution is ISIS, now under replacement with SID, a package for reliable distribution developed at the neighbouring SICS, Swedish Institute for Computer Science. The “horizontal“ CoDesk interface is developed in the object oriented InterViews package. For the “vertical“ tool prototypes existing freeware on Internet, i.e. nv and vat, are used for video and audio communication. Other tools, e.g. collaborative note board, email, collaborative drawing are developed at IPLab and SICS in Smalltalk and InterViews.

This prototype has been used to demonstrate, e.g. at (Tollmar et. al 1994), our ideas to a broad range of plausible users. It has been notable that this approach has reached another community that the earlier HyperCard prototypes. The computer science challenge to realise parts of the CoDesk environment has give us a forum to reach the very living and rich “hacker“ community.

Technical constraints have postponed evaluation studies in real work settings, but such studies are now feasible very soon.

Paper mock-ups

The demanding task of building a working and usable “prototype“ of the CoDesk environment has lead us to use an alternative way to build prototypes - paper mock-ups, an obvious, quick and easy method with demonstrated usefulness, e.g. (Ehn and Sjögren 1991). One of the most obvious gains is that it is clear that a design on a paper model is not fixed and could easily been changed which can give a more creative and non-constrained discussion of alternative designs. This tends to relax the discussion and those make mock-ups an excellent medium to communicate about design, especially in collaborative design of collaborative system (Bødker and Grønbæk 1991).

A very simple form of paper mock-up is overhead slides, used by everyone, not necessarily thinking of them as mock-ups. Other forms of paper mock-ups are:

- Abstract cards that could be used as a game.
- Screen shot to perform walk trough in the system.
- Paper and pen for sketch.

In our initial approach have we experiment with using screen shots, see figure 6, to illustrate system walk through and testing of the metaphors. It is obvious is that in order to successfully use paper mock-ups in the design a lot of training and experience is needed. Nevertheless a couple of outcomes have been easy to identify.

Figure 6 - Using paper mock-ups in the design.

First of all the basic understanding how direct manipulation in a desktop interface is not as common as we expected it to be. There is often a rich variety of different ways to perform a certain task. Even if the basic functionality in CoDesk is rather mundane (that is just the intention) we need to provide a multidimensional orthogonal set of functions that is consistent.

Naming is also important. The use of common names is a key factor in group cohesion. Therefore in collaborative environments are needed mechanisms for name proposals, e.g. given a new object or given a new user. The first alternative is useful in situations when a user wants to merge an object into a new context, in order to find an appropriate name in that context. The second alternative is relevant for novice users; as objects may have multiple names, it makes sense to offer name proposals to the user for such objects.

Recently we have made some experience in use of paper mock-ups to experiment how an environment like CoDesk can be used in a real work situation. Our preliminary results follows earlier experience, like the “Organisational Kit (Ehn & Sjögren 1991), claiming that this form of situated design could have a strong impact how a system is incorporated into an organisation.

Video

A traditional design medium is video presentations. In some situations video can be used as simplified replacement, missing the dynamic part, of live. We will just mention the most obvious features in using video that we find important to be addressed.

A strong feature of video, especially for CSCW prototypes, is that it enables us to show persons using the system in different environments. In a video the time can be manipulated so we can show scenarios that span over longer periods.

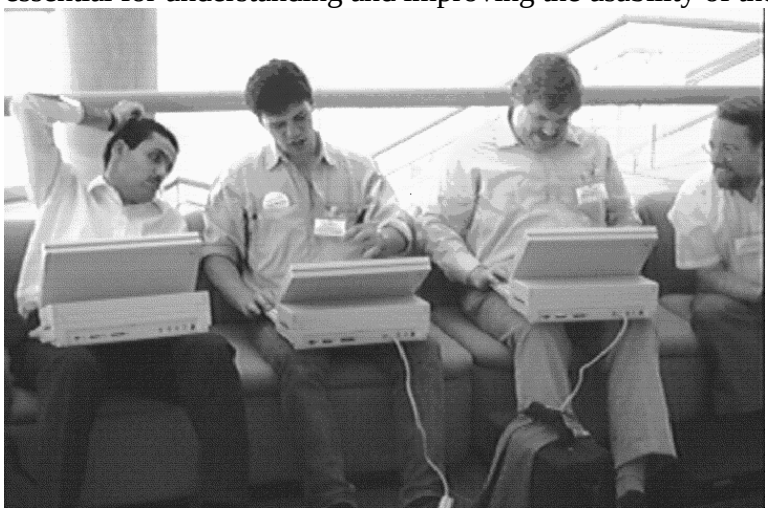
User Evaluation Studies

In this section will we summarize the major evaluation studies that have been performed in the Collaborative Desktop project. Our main focus has been to develop an understanding of how to enrich a mundane workplace with CSCW features in a non intrusive way. As the design turned it defined a dual design goal for the CoDesk system. The dual design goal state that the system should attract from use of the system from two sides. On one hand it should be a plausible, and better, replacement from the normal desktop environment that is commonly used today. On the other hand, as a long term effect, it should lead the users to use and benefit from the communication and sharing features that exist within the system.

To do so there are several aspects to consider. We have examined the different aspects of the Collaborative Desktop some user studies. Here will we describe three of these studies.

What to study?

We will here focus on 8 topics that have emerged from the studies to be especially essential for understanding and improving the usability of the Collaborative Desktop.



How to use todays desktop

First of all we need to better understand and experience how people today uses their digital desktops. What functions are most appreciated and which are more seldom used. Do people in general understand some of the subtle features in direct manipulative interfaces?

How well does our metaphor match different needs

With the use of multiple metaphors a natural issue is how well does these metaphors fit and if they can co-exist in the users mental model? And do the metaphors articulate the usage for different work tasks?

What tools are wanted

The kinds of tools wanted for CSCW activity vary a lot. Most research activity has been devoted to three classes of tools: coordination - Email and message system (Mackay 1988, Malone 1988), collaboration - writing and drawing tools (Neuwirth 1994, Lu 1991) and communication - different forms of media spaces (Borning 1991 and Root 1988). We would like to match this with what the expectation on CSCW tools is. But doing so under light of what kind of tools that are used and appreciated today.

Social awareness

While many researchers have pointed out the need for social awareness it is still unclear of how to do it. Practically certain criteria's should be fulfilled. Gaver (1992) discusses the benefit of using peripheral awareness that uses the human capability to peripherally process not-attended parts. Dourish and Bellotti (1992) claim the obstructiveness by non-controllable system and suggest passive system. But in order to share any awareness people must be willing to expose themselves and their activity. Fundamentally the gain has to be bigger than the cost.

How to handle information overload

The need to handle the “information overflow“ has been characterized as a change in the social paradigm of society (Kumon S., 1992) and different visionary computer based solutions have been suggested (Bullen and Bennett, 1990) and (Engelbart 1990).
Are those suggestions reasonably? Do people in general put that much efforts to e.g. make annotations? How does population of information spaces happen?

How do people organize and share information

Several studies of how information in paper form is shared (Blomberg et al. 1994, Hughes & King 1992, Malone 1983) has give us a basic understanding of the intrinsic relation between work practice and organization policies. Informal communication and

sharing are of outmost importance to enable work in a rational and pleasant way. But even if the mechanisms exist do people share information voluntarily? What can encourage them to do so?

How to group and use context

Studies of how users organized and find electronics files in a desktop environment have showed that users preferred location-based finding (Barreau and Nardi 1995). This suggests that logical placement, e.g. by a name or by time, is more time consuming and takes more efforts.

But what about shared spaces - how do we organize for a shared use? Location information seems to have another purpose in giving a context. Barreau and Nardi reported e.g. by placing object near the trash it indicated and reminded that they should be deleted. How do we share and manipulate both the objects as well as the context?

The Room Metaphor Study

We have chosen the room as metaphor for cooperative activities. But why the room, why not shared desks since the basic metaphor is the desktop. What is a room, how can we use the room metaphor and what benefit does rooms have compared to shared desks. Several researchers have come to the conclusion that room is something more than a space. The social significance of rooms becomes evident in studies of workplaces (Heath & Luff 1991, Hughes & King 1993). Bowers (1993) claims also that rooms affords boundaries that can be used for context as well as provide different modes of awareness. As Moran & Andersson (1990) argue one of the use of rooms is that it forms a place for activity by social conventions.

Marmolin (1993) summarize rooms functions as a kind of artifacts in coincidence with Robinsson (1993) discussion for the importance of multidimensional tools to:

- Getting the job done
- Supporting peripheral awareness
- Implicit communication
- Organizational awareness

To future exploit the usefulness of rooms did Marmolin (1993) an assessment of the room metaphor with aid of a theoretical assessment method originally proposed by Caroll (1988). The method gives a framework for a theoretical assessment how a target domain map into a source domain. With aid of a couple of scenarios does the method indicate where the target domain and the source domain match or (and) mismatch.

Marmolin find "three inevitable discrepancies" between the target domain, the use of rooms to represent context and collaboration in a computer system like CoDesk, and the source domain, the normal use of offices.

In the source domain both direct and indirect interactions are plausible while in the target domain only the latter style of interaction, through some tool, is possible.

The users point of view is also different. In the source domain our users are bounded with their experiences - an inside-out representation of the world. The never sees themselves while in the task domain the user sees themselves together with others, a bird view. A natural outcome, but maybe not negative, of 3D in the source domain compared with 2D in the target domains.

Four different scenarios where assessed in this study: visit an office for discussion, form a collaborative team, having a meeting and call a team member.

Visit an office for discussion

In both the target domain and source domain the procedure is similar: Find the office versa go to an office, observes the office to see if the owner can be disturbed, knock on the door versa call the owner by clicking on a communication tool, enter and start the discussion.

Note: Even if this match well has the interface been changed in later version. Persons in the new interface have a direct representation and not indirect via their office. Also do we

find a match in the source and target domain. Compare, e.g., how cellular phones are used - you use a virtual representation to reach somebody without knowing their physical location.

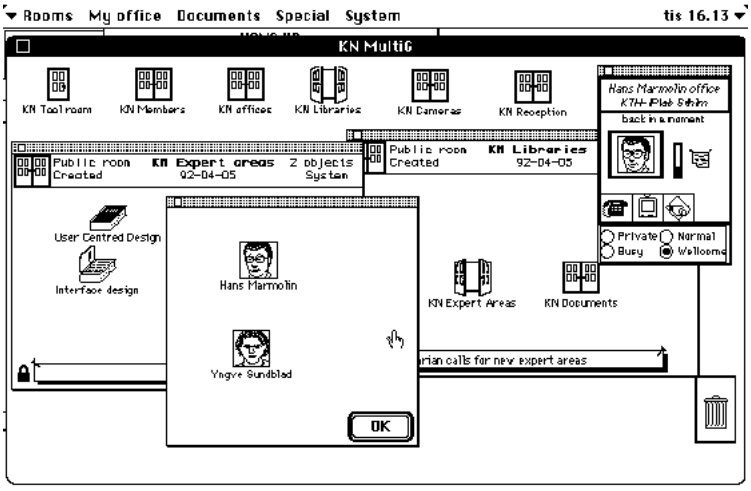


Figure 1, Prototype of an early CoDesk interface with members, public rooms and offices.

Forming a collaborative team

Also here remind the target domain overall of the source domain: Negotiate with the team members and then find some common space versa create a team room.
Note: Finding a common space is probably harder than create a virtual teamroom.

Having a meeting

Both in the target domain as well as the source domain: inform the team members about a time by placing a message in the shared room, put needed material in the room and be there at given time.

Note: The major difference is that the source domain needs some kind of representation of the meeting in the room. Just being in the virtual room does not have to mean that a meeting is happening.

Call a team member

The target domain differs significant from the source domain. In the target domain rooms can be used to provide awareness about a person's presence while in the target domain you don't really look into their office to see if you can call them.

Note: This kind of peripheral awareness is just what we would like to gain.

Conclusions

The last scenario showed us one of the strength of using the room metaphor as we indicated above. Rooms have the advantage of being familiar spaces for social interaction as well supporting boundaries and awareness.

In a similar assessment of using shared desks this did not turn out. Even if individual awareness where stronger with shared desks lack of group awareness was notable. To support individual awareness better while using room have we keeped the notion of a personal room. This personal room is in main focus and the first thing a user will see when starting the Collaborative Desktop. This room forms a space to place individual material and material intended to be shared.

The Cardboard Computer Study

We selected to use paper mock-ups to study how people evntually would use the Collaborative Desktop. The use of cardboard computer has earlier been succesfully used with in our laboratory (Ehn & Kyng 1991). As Ehn & Kyng noted is the major benifit of cardboards computer thay they form a common design language. A language that

"resamblence with other language games" that the participants know how to play. The paper mock-up's main dutie is then to set the stage and support interaction and reflection.

What to study?

Several things were intended to be captured with this study. We needed to clarify the common understanding of the traditional desktop metaphor. Future more did we want the users respond on how they conceptualize the new object on the CoDesk desktop. We asked if the informants could with the paper mock-up build an image of their organization using the group object. We also asked if they could build with, the room object, a collaboration situation from their own experience. Finally we asked if they could with the different tools search and trying to contact some colleagues with a specific question in mind. Afterwards we discussed how they experienced the mock-up and asked them for plausible improvements that they had in mind.

Our user group

The study involved twelve people. They where representing 3 different kind of plausible CoDesk users, students, professional researchers working with computers and other professionals that have daily use of a computer. Four was selected out of each group. The average informants had been using computer for at least 3-4 years and use it for 1-2 hours per day except for some of the professionals that could use it for 10-12 hours per day. Six persons normally use two, or more, different kind of computers daily, like e.g. Macintosh and Sun. All the informants use some kind of word processor but only a few claimed that they regularly use some drawing and image editor. Two reported that they use spreadsheet tools both of them also use some kind of database tool. Nine of the informants have daily use of some kind communication tool, preferable Email but also news and WWW.

The scenario

A scenario was used for, to organize, the study. The scenario naturally overlapped the different parts in the study and created meaning to the different parts. For that reason did we prepare a kind of storyboard of screens on paper that act as our paper mock-up. Beside the storyboard did we also use a "working" paper mock-up with flipable menus and small paper icons that was used when the informants did a couple of the tasks.

In the scenario did we put in discussion points that where used to make the study more informal by giving the informants a direct feedback on their reactions. A second purpose was to give them an opportunity to articulate in words instead of action if they did not succeed in using the paper mock-up in a certain task. Each study took almost 2 hours,

Understanding of desktop

Without introducing the CoDesk model did we with the paper mock-up, ask them to perform a couple of tasks to get their basic understanding of today's desktop model. We specifically asked about the conceptual understanding and visibility of the different kinds of the object that exist on a desktop today. We also asked how the direct manipulative

interface was conceived. How they sort and remember locations of objects and if they use any strategies to label objects to easier retrieve them later on. Of especially importance was if they have any experience with sharing and what kind of strategies they want to employ when you share objects.

Icons

Most indicated a slight differences between documents and application icons. Folders, or catalogues, where easier to diffricence. None where able to express an idea of a visual language behind the form of the icons. Experience told most of the informants what kind of application or document its icon represent. Combined icons was suggested to be more usuable, maybee with a cooperative or product logo that could earlier be experied through other media. Text labels on icons where founded necessary.

Direct manipulation

Double click - yes, drag and drop - no. Even if drag and drop is needed in the Macintosh desktop, e.g. in sorting and trashing, only a few expressed any experince with direct manipulation on desktop objects. One of the task was to open a word document with framemaker. We told them that framemaker can read word document but none suggested to drag and drop the icon of the word document on the framemaker ikon. Even if almost all prefer desktop operation to work with objects, like e.g. double click on an icon instead of open it from the meny inside the application.

A recent documented (Weaner 1995) redesign of the Drag and Drop functions in one of the major desktop environments gave us some valuable insight. The shortcomming seem to be that very few use the subtile and andvanced funktions in direct manipulation interfaces. Most of us use only a small set of aviable function and find ways to work around by translate those action into the trained and predictiable set of opertions. In our case lack of respond, especially drop site feedback, is one obvius reason.

Sorting and retrivel

In the next set of task we ask the informants how they would sort some objects, it was around 20 different objects off all kinds. Some of them where related by name while other by type.

In generall did most claimed that that feel rather unconfortable about the sorting possibility in desktop interfaces. The strategie that was applied was to use clever name, sort hieracial, look for objects in time order and reduce the number of files. Names are commonly personal associations and iff eventuall search information exists it is embedded in the name.

Few mentioned that they sort based on spatial location even if in the paper mock-up scenario most did. The result resambled indead with two other studies that had in deep focused on the way uers organize and find files on their computers (Barreau & Nardi 1995). Users seem to prefer what Barreau & Nardi call locatin-based search, which roughly mean that the user take a guess of where to look and in that location browse around. Few seem to use text-based search on keyword or file names. Clear is although that there is no real conflict between the two different strategies - they could very well co-exist in an ortogonal search space.

An important observation that Barreau & Nardi did was the possibility to classiy files into three types: emphemeral, working and archived. The most differcult problems seem to arise when dealing with emphemeral information. Machintosh users preer to keep such information visible but real problem arise when delays force a users to keep that kind of information longer than expected. Barreau & Nardi argue that tools that handle this kind of short time information is the real lack in todays sorting possibilities on e.g. a Macintosh desktop.

The CoDesk model

Most of the discussion did concern what kind of attributes you would like to use for people, in the person object. In a scenario the informats where asked to list the attributes they would like to find. Afterwards we revesed the question and asked the subjects to provide information about themself.

Name, phonenumber, address, etc. seem to be obvius. More discussion was raised on whether organisational belong and work description was important. One of the informats gave an example, who has a license to operate a specific device in a hospital, when work description was a shared common interest. Obvius was the unwilliness to provide more personal information. All reject the suggestion of informing about personal interest, e.g., hobbies (note onn WWW homepages). Also clear was the unconfortable in defining your self as some kind of expert.

A plausiable replacement instead of declaring your skills could be the revers - declare some areas that you would like to know more about. Instead of searching for an certain expert, e.g., do you look for people sharing the interest of learning more in some specific domain.

Another suggestion was to use a more free form, like a drawing tool, to provide information about your self. Thats maybee implicity leaves personal clues instead of the unwanted explicite.

Creating a shared collaborative setting

Of greet interest was to let the informats put togheter fictiva work settings to see how they use the differnt tools and what object they find was of importance for them. In a couple of cases where we able to match the differnt perspective that the individual has on a specific work setting.

The first task was to form, using the group object, a representation of the organisation that the informats work within. We pointed out the possibility of alternativ groups like a mailgroup. The second task was to select a project from one of those groups and with the room object form a collaborative setting. Here we discused the use of different form of communicational tools and other means of how to keep in contact. One of the problems was to see if we could use multiple representations of person, etc...

It was natural for almost all to use multiple representations of person. Even if some kind of home for each person was indicated to be usable a person could appear in many different context simmultanius. Also clear was the need to have both shared as well as private groups. Private rooms did not seem to be that usuable.

A couple of the informats pointed out the lack of "things" within the rooms. There was a disire to interior the rooms in a more personal manner. Also needed is a clearer visual disperety that separate the different objects and contexts from each other.

Trying to contact a collegue

Since several of the assumption failed because the unwilliness to provide more personal information and to declaring skills one of the scenario become unrealistic. Notably is the fact that if you just ask wheather people would like to find, e.g., expert within an organization the normal reaction is entusiastic - but as it turned out maybee not feasible.

In the other scenario we tested the usability to reach some within a group wich turn out rather well. The solution is to provide also the group object with a description attribute. That is probably also valid for the room object.

Overall opiniums

After the scenarios we had a small discussion about how to improve the CoDesk environment. We asked three question: improvement in usability, improvement in the interface and improvement to strenght the awereness. Here we list the most common sugestions

Improvement in usability

- Overview of especially groups.
- Description attribute on each object.
- Common whyteboard.
- Integrated tools.
- Calanders and tools for resource allocations.

Improvement in in the interface

- Visually clearer context, use adecvate visual artifacts to represent and differentiate Rooms, groups and folders.

• An improved room interior with more things (objects) in the rooms, e.g. templates for meeting protocolls, "fax" machines, notebooks etc.

Improvement to strenght the awereness

• Local communicatin tools
• Inventations for social contacts.
• Better visual design to indicate awerness.

Clear is that what is need is to improve the visual design, provide better context, awereness and overview.

Also some tools that we did not thought as importance was lacking. The calander was simply postponed due to earlier experince of the differculties in designing shared calanders. A new tool for us was this local communicatin tools that was suggested by the idea of having some kind of intercom within a group or room.

The Tool Study

(Ellemtel text?) Within a study on videokonference system and mediaspace environment did Ahlström, Marmolin & Marmolin (1993) evaluate the usability of tools in a couple of different collaborative situations. A questionar form asked 18 person about there normal workpractice, what kind of tools they use today to handle that kind of communication and how they evaluated the use of some future computer supported collaborative tools. Example of the situation was:

Give information of a common project to your collegue. You have the information on your workstation.

Create a document together. The document should cointain both text and drawing.

Discuss a research topic together.

Discuss and create a plan for a project with resource allocation and deadlines.

Notable was that in the situation where the collegues location where close, within 10 minute, and where relative few, lesser than six, most prefer a meeting in favor for some computer mediated communication tool. But in other cases where it propably should be to time consuming, distance, or to complicated, to many people, several CSCW tools was suggested to be usefull.

To present the result in more detail have we classified the different form of cooperation into three classes: discussion, planning and advising. Those term are selected on the informats descriptions of their work.

The result indicate that planning take most of the time, see igure 1, with todays tools and pratice. While with the use of CSCW tools advising will take most of the time.

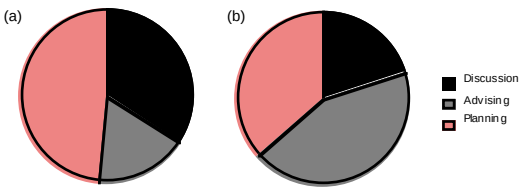


Figure 1. The distribution of estimated time in three different form of cooperation, split into (a) traditionel communication tools and (b) CSCW tools.

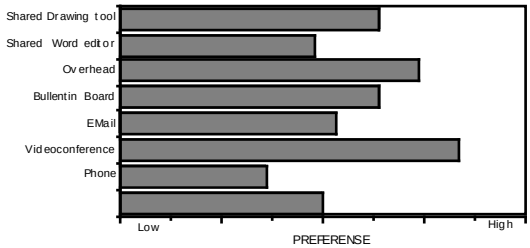
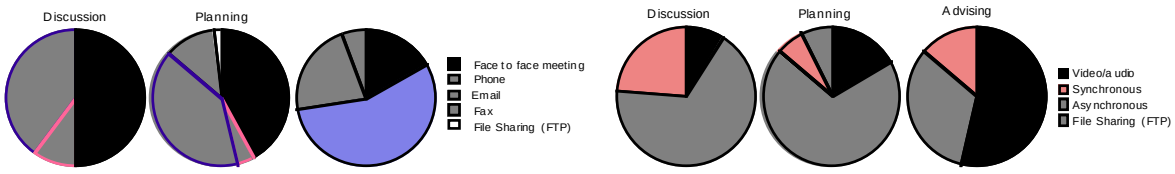


Figure 3. Estimated usability of CSCW tools.

The questionar ask the informats to rank the CSCW tools usability in the different situations. The result from this could be find in figure 3. Videoconference and overhead was judge to be the most usuable tools, while phone and shared word processer was valued a bit less.

Figure four describe how much time is put in traditional communication tools. The time is divided into the three different form of cooperation: discussion, planning and advising. Face-to-face meeting take the largest proportion of discussion while the use of the phone seem to be predominat for advising. In all situation is the use of email frekvent.



Figur 4,. Distribution of estimated time in the different form of cooperation using traditional communication tools.

Figur 5. Distribution of estimated time in the different form of cooperation using CSCW tools.

To be able to compare the different CSCW tools they where cluster them into three kategories:

- Video/audio - desktop videoconference, phone and videoconference
- Asynchronous tools - mail and bulletin board.
- Synchronous tools - shared word and drawing editors and overhead

Figure five illustrate the estimated time how to use the differnt tools in the three situations. Asynchronous tools are expected to be most used in discussion and planning while for video/audio are suggested for advising.

The study showed that beside the traditional communation tools like, e.g., mail and news there was a big demand for video/audio communication tools. Future more did the group estimated video/audio to have a high usability.

Even if a majority of the group expressed the unconfortunable with how much time that where spend in project and team meeting did several claim that most of these meeting could not be substituted with videoconference meetings.

The study did also showed an expressed need for informal contacts, like in advice situations. Todays is only a small time is devoted for advice situations even if this kind of situation are estimated be the most usable for CSCW tools. It could be a lack in todays tools that minimize or not support this form of communication. Today is the phone mostly used for this form of communication but the result indicate the unsatisfaction with this type of communication.

Conclusions

In user studies the room metaphore, the interface (as a cardboard computer) and some tool of CoDesk have been evaluated in cooperative work situations. The strenght of rooms as cooperative areas, as familiar spaces of social interaction, has been demonstrated, also when compared to a shared desks metaphore.

The cardboard computer evaluation captured many relevant user comments guiding clear improvments of the interface.

The not yet completed study of users preferences of communication tool indicate a clear role for video/audio in synchronous cooperation situations.

Future Work

Not covered here - but the subject on a fortcomming paper - is the impact tools supporting both social and work awreeness have on a group. Especially the long term effect on groups of people working togheter. We are currently in the midle of a study where we with a couple of tools has been able to give a group of people the possibility to share some common awereness like current situation, future plans etc. Indication sofare has hinted that combination of social and work awereness, in certain environments, do strenght each other in a very strong way.

New Interaction Styles

In our development of the different prototypes arguments for providing alternative interfaces to the traditional desktop model have emerged. There have been suggestions

from enriching the desktop with support for group cohesion like yellow notes to providing new interfaces, e.g. World Wide Web pages.

In order to explain the continued development of new interactions styles in different kinds of interfaces to Collaborative Desktop we give a short introduction to the supporting technology used to realise the Unix prototype.

Supporting Techniques

A considerable amount of work building the Unix prototype has been on redesign in supporting technology that normally is used for multi-user application, e.g. database management systems and distributed systems, to fit better to a CSCW environment. These concepts have been developed in the framework of the COMIC project in a joint effort to develop a Shared Object Server (SOS) (COMIC 1993, 1994). Here we highlight the distinct uses of two central features in the SOS: the use of events to provide awareness and sharing of objects through an extended persistent storage manager.

Events

The CoDesk should enable users to be aware of the actions of other users. The mechanism used to provide this form of awareness is event handling. The implemented services provide facilities to allow events to be defined, created, related to others and handled in appropriate ways. Users and object can declare interest in certain events or types of events by registering a subscription to such an event. When any action takes place on an object, that is of possible interest for other object, events are generated and distributed to the appropriate subscribers.

Sharing objects

As stated above co-operation mediated through a group's working material needs to be supported in a CSCW environment. A considerable amount of work in the CSCW community has been devoted towards co-ordination and communication (Fosdick 1985) (Patterson 1990)**.** CSCW support for time and place independent shared objects has been addressed by e.g. multi-user hypertext system, such as SEPIA (Haake & Wilson 1992) and co-operative authoring system, such as Quilt (Fish et al. 1988), but more mechanisms are needed.

The feature which most distinguishes the sharing of object in CoDesk from most other multi-user storage systems is the focus on sharing and the provision of mechanisms which support the management of this sharing.

One of the most important functions is, again, to integrate the use of new tools with current system(s). A strong demand has been to simultaneous access the persistent shared object and the normal file system. By handling the persistent shared object with an extended object oriented database we could easily integrate the file system into the shared object space as well as access the database from the file system and hence perform a smooth translation between the two different worlds.

The extended object oriented database does naturally also provide a lot of other functionality that is useful for CSCW systems, such as, e.g., versioning, a flexible naming manager, persistent queries and history of objects.

New Styles of CSCW desktops

As argued earlier visually representations of co-operative awareness are needed so that users of shared resources can be aware of the presence of other users and their access to the shared objects. This form of awareness on per object basis is only one dimension of several.

Cooperative awareness that spans multiple objects, in time, seems equally important. Group cohesion is normally gained using bulletin boards, or some other common area, to

place notes, drawings or messages. A generic multipurpose note service like “yellow notes“ would be useful, se figure 7.

Figure 7 - "Yellow Notes" + Visually context on the desktop.

Another outcome from the paper mock-up prototypes is that support is needed for visually provided contextual clues — like identifying different environments. An example is the way TV-channels use their logotypes on screen. On the desktop the environment could be represented as different forms of background and the use of personal icons and layout.

Alternative interfaces to CoDesk Shared Object Space

Suggestions from the prototype work have lead us to figure out alternative interfaces to the shared object space that are inherited with use of CoDesk. Users want different forms of light interfaces to some of the functionality and some users also want textual interfaces. We have therefore developed some alternative interfaces to allow the use of the shared objects from different operating and hardware platforms.

We are currently doing user-studies on a set of tools that are directed to provide awareness within a group. The tools provide interfaces from plain Unix-commands, world-wide web pages to a media space tool like the Ravenscroft at Xerox (Gaver et al. 1992).

An increasing interest for using text-based virtual reality system, or Multi-User Dungeon MUDs, has opened our eyes into this community. Both social phenomena and interface problems have a lot of similarities to our work. Lately several interesting room based MUDs have been used to model work environments. Those communities are playing an increasing part in the daily lives of a broader and broader segment of the population (Curtis 1992) (Bruckman 1994). Especially notable is the Oxygen system from Art Technology Group that both provides an advanced graphical interface and is used in real work environment (Frank 1994). We believe it would be an interesting challenge to make a MUD with the CoDesk Shared Object Space.

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