Interaction design patterns for computers in sociable use

Mattias Arvola

Abstract: This article contributes to a growing body of design patterns in interaction design for cooperative work, while also describing how to go from field studies to design patterns. It focuses sociable face-to-face situations. The patterns are based on field studies and design work in three sociable settings where desirable use qualities were identified and translated into forces in three design patterns for controlling information visibility. Based on the patterns, the design of a multiple-device multimedia platform is described. It is shown that desirable qualities of systems-in-use can be utilized as forces in patterns, which means that traditional qualitative research is highly valuable when documenting design knowledge in patterns. Three classes of interaction design patterns are identified: environments for interactions, means for interaction, and interfaces for interaction. These classes describe types of patterns within a hierarchical model of interaction design.

Keywords: HCI, CSCW, social computing, co-located collaboration, design patterns, use quality, interaction design, cooperative systems.

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1 INTRODUCTION

Within the area of computer-supported cooperative work (CSCW), many qualitative field studies have been made to document cooperative systems that work and does not work in co-located collaborative and sociable situations of use (in short sociable situations). Only few of these field studies have arrived at patterns that can be readily employed in a design situation (Junestrand, Keijer, and Tollmar, 2001; Martin, Rodden, Sommerville, Rouncefield, Hughes, 2002; Martin, Rodden, Sommerville, Rouncefield, Viller, 2001; Arvola & Larsson, 2004, Arvola, 2005). The aim of this article is to illustrate how design patterns can be used for documenting design knowledge from field studies and explorative design work. This article hence contributes to a growing body of design patterns within CSCW, while also having a methodological focus.

1.1 Computers in sociable use

The area of interest for this article is sociable use of computers. That is, situations of use where several people at the same time and the same place work together towards a joint goal. In such situations, computer users need to shift fluently between working individually and working collaboratively, but doing so is not always straightforward (Baecker, 1993). An example of one such situation is customer meetings where clerks explain something and swivel their screen towards their customers (Scaife, Halloran, and Rogers, 2002; Rodden, Rogers, Halloran, and Taylor, 2003).

There are several approaches to designing computer applications for use in face-to-face situations. There are, for example, interactive spaces that assist co-located collaboration. This approach involves augmenting physical objects with computer power and integrating the design of computer applications with the design of physical space (Wellner, Mackay, and Gold, 1993; Streitz, Rexroth and Holmer, 1997). Examples include different kinds of electronic tables (Streitz, Tandler, Müller-Tomfelde and Konomi, 2001; Scaife, Halloran, and Rogers, 2002; Rodden et al., 2003; Halloran, Rogers, Rodden, and Taylor, 2003), and entire electronic meeting rooms (Nunamaker, Dennis, Valacich, Vogel and George, 1991; Streitz, Rexroth and Holmer, 1997; Geisler, Rogers and, Tobin, 1999; Sundholm, Artman and Ramberg, 2004).

There are also applications utilizing single displays to enable shoulder-to-shoulder collaboration by means of

simultaneous input to a shared display. These are denoted Single Display Groupware (SDG) (Stewart, Bederson and Druin, 1999).

Most of the systems designed to support co-located groups have focused on joint use alone. With multiple-display solutions users have, however, the opportunity to work privately on a personal screen, such as a handheld computer, while also allowing them to share information on a public screen (Myers, 2001). Software distributed over multiple devices can be said to have distributed interfaces (Bång, Berglund, and Larsson; 2002; Sjölund, Larsson and Berglund, 2004).

One such distributed interface is Sharednotes, which was designed by Greenberg, Boyle and LaBerge (1999). In that system, notes could be either completely private for individual use or completely public for joint use, but nothing in between. This approach did not work sufficiently well and the authors recommend a design that allows users to fluidly shift between private and public work, including the many gradations in between. This article clarifies some of the important dimensions of this problem in the form of design patterns.

1.2 The original Alexandrian patterns

During the seventies Alexander and his team (Alexander et al., 1977; Alexander, 1979) developed the concept of 'design patterns' within the field of architecture. It was a reaction against the kind of buildings that had been built within the modernist tradition, where many of the immeasurable qualities of architecture had been lost. The patterns that his team made, strive at resolving conflicting forces, wants, needs, and fears that exist in the usage of a building.

Every pattern describes a recurring problem, its context, the forces that are at play in the situation, and a solution to the problem. The feature that solves the problem is written in a generic but concrete way, so it can be designed in an infinite number of ways, while still being readily identifiable. Anyone should be able to see if a design solution has a particular feature or not. This is especially important to help non-specialists to participate in the design. In a well-written pattern every reader should also readily recognize the problem. A pattern can be seen as a working hypothesis; each pattern represents the current understanding of what the best arrangement is for solving a particular problem. For this reason, it is important that the pattern is clear, sharable, and debatable.

Saunders (2002) has reviewed Alexander's work on design patterns and he notes that the research community in architecture, to a large degree, has ignored Alexander's work; it has been seen as an expression of utopianism, essentialism and environmental determinism. In addition, evidence of critical thinking and careful research is lacking in Alexander's patterns. The values that are embedded in them are treated as universal and absolute, and are not subject to reflective thought. Saunders argues, however, that design patterns should not to be read as recipes. They should rather be seen as imaginative and debatable descriptions of insights about how to solve potentially conflicting needs. As such they are means for fleshing out the social and experiential reasons for certain design solutions.

1.3 Design patterns in HCI and CSCW

Within human-computer interaction (HCI) a number of different formats for writing patterns have been suggested (e.g. Granlund and Lafrenière, 1999; Tidwell; 1999, 2004; Erickson, 2000; van Welie and van der Veer, 2003; van Welie, 2004), but they are seldom as vibrant, alive, and concrete as Alexander's original style of writing. Martin et al. (2001, 2002) advocate a descriptive form of patterns in CSCW. They include vignettes that are real examples from their own and other's fieldwork in order to contextualize the patterns. They do, however, not provide the concrete solutions to concrete problems that designers seek, but they are certainly grounded in empirical evidence and critical thinking.

Guy (2004) reports on the use of design patterns together with socio-cultural activity theory to form activity patterns. In activity theory, human activity is conceptualized on three levels: operation, action and activity (Leontiev, 1978; Kuutti, 1996; Bødker, 1989, 1996). This is mapped onto design patterns to form activity patterns on those three levels. Clicking a button in a familiar graphical user interface is for example an operation: a non-conscious act driven by conditions in the environment. Writing a note is an action; it is conscious and driven by an explicit goal: to achieve the note would be the goal. The highest level is the activity is driven by motives, and an example of an activity would, for instance, be editing a special issue of a journal, and the motive would be to get the final version of the special issue. Patterns for designing activity can, according to Guy, be on any of these three levels. I have argued elsewhere (Arvola, 2005) that the same levels can be mapped onto the design objects of interaction design.

van Welie and van der Veer (2003) identified five levels of interaction design patterns: business goals patterns, posture patterns, user experience patterns, tasks patterns, and action patterns. These levels overlap with the three levels Guy uses based on activity theory. Business goals are on an organisational activity level, i.e. it consists of complexes of activities and shared motives within organisations. Postures are the kinds of systems that are built, structured in terms of the purpose of the system. Is it, for example, an e-commerce application, a personalized portal or an online community that is to be designed? The posture connects higher-level motives in the activity of use with business goals. User experiences refer to activities of users, for example playing, informing or shopping. Tasks are basically the same as actions in activity theory, and task patterns describe sequences and flows of interactions on various objects. Finally, actions are at the level of operations in activity theory, and describe small parts of the tasks such as pushbuttons, logins, and choices.

This article reports on the development of a collection of design patterns for computer applications in co-located collaboration. Below follows a description of how they were developed before the patterns themselves are described. In the discussion the patterns reported here are related to the models of multiple levels of interaction design patterns reported by Guy, as well as van Welie and van der Veer.

2 METHOD

Three cases of computer applications in co-located collaboration were investigated in a collective qualitative case study (see Walsham (1995) for a discussion on such case studies): professional computer use during consultation at the bank, educational computer use in studio work, and leisure use of multimedia platforms in domestic environments. The empirical work in these settings includes meeting all in all 49 participants during 41 observation and semi-structured interview sessions ranging from one to four hours, and 17 half-day workshops. The written up and transcribed field notes were analyzed, and three prototypes were built during explorative design work to elaborate the patterns in interpretative iterations. One of these prototype systems is described in this article to provide a concrete form based on the design patterns. It is a multimedia platform called Locomotion, which is based on multiple stationary and mobile devices. The design of the other prototypes is reported elsewhere (Arvola, 2005).

2.1 Use quality analysis

All written up and transcribed field notes and design sketches (ca. 500 pages) underwent an analysis of desirable use qualities. Two methods, quite common on social studies, were used in the use quality analysis: the concentration method and the categorization method (Kvale, 1997; Ely, 1993). Finally, the three settings of sociable use were compared to each other to find similarities and differences.

The concentration method was firstly applied to the material. The first step of that was to get a feeling for the material by reading through the written up and transcribed field notes and listening to or watching the recordings. The second step was to find meaningful episodes in the texts where participants expressed their view on the use of interactive systems in sociable use or when observations regarding the same issue had been made. For example, one informant noted that a system at the bank should not disturb the customer meeting. The third step was to concentrate these meaningful episodes in the text to short phrases that expressed a central theme from the perspective of the participant, and this theme was scribbled down in the margin (e.g. 'customer in focus'). The fourth step was to put the question of what the sociable use should be characterized by to the meaningful episode. This provided an initial list of desirable qualities that the systems should display in use.

The categorization method was furthermore applied to the empirical material. Descriptive qualities were transformed into prescriptive qualities (e.g. 'difficult to go between systems' turns into 'seamless tool integration'). The number of categories of use qualities identified was at this stage vast and in order to get a more manageable set, the method of affinity diagramming was applied. This means that the categories were grouped and sorted according to their affinity to each other and higher-level categories were formed as the groups were named (Ely, 1993; Holtzblatt & Beyer, 1993).

At this stage the categories were used to code the empirical material. The qualities were, during the coding, tied back to excerpts from the empirical material to make sure that nothing had been lost in the abstraction.

2.2 Pattern identification

Conflicts between desirable use qualities were especially noted during the use quality analysis since they formed a basis for the problem statement in design patterns in terms of conflicting forces. One such conflict was, for example, between autonomous personal work and participation in joint activities. When a problem of conflicting use qualities or tensions between use qualities had been identified the next step was to identify features of situations where the use qualities were not in conflict. If such a feature could be identified it could be a solution to the tension, and then a design pattern could be written.

As earlier noted, a number of different formats for writing patterns have been suggested within CSCW, HCI and interaction design, but I have chosen, as Junestrand et al. (2001), to present the pattern in Alexander's original style of writing.

3 RESULTS

It is now time to turn to the design patterns describing solutions that have potential to provide desirable qualities for interactive systems in sociable situations of use. Earlier formulations of the following patterns have had other names (Arvola & Larsson, 2004; Arvola, 2005). Additional patterns for sociable use, including other kinds of connectors (GO CONNECTOR and SEND CONNECTOR) as well as further empirical evidence have been reported elsewhere (Arvola, 2005).

3.1 Pattern 1: WORKSPACE WITH PRIVACY GRADIENT *

. . . people engaged in COLLABORATION IN SMALL GROUPS (Martin et al., 2002) work jointly, but also individually. For instance, financial advisors in customer meetings do individual work while collaborating with customers, and quite often people do things on their own while watching television with other family members. It is therefore important for people to be able to control their

objects of work and fluently move them between private and public states, including gradations between (Greenberg, Boyle & LaBerge, 1999), but so far no pattern has shown how to do so.

This pattern can be used to figure out the information management details of work places (physical or computer-based) provided by Alexander et al. (1977) in INTIMACY GRADIENT (127), SMALL WORK GROUPS (148), HALF-PRIVATE OFFICE (152), and ALCOVES (179). The pattern also complements the PRIVATE AND PUBLIC DIGITAL SPACES (127b) (Junestrand et al., 2001).

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In social face-to-face situations, people need to work individually on private objects of work as well as jointly on public objects. Hindering people to work individually is impolite and causes frustration, and so is excluding them from participating. Any object can however be needed for individual work or joint work. People accordingly need to manage the privacy of their objects of work.

In all social face-to-face situations people perform autonomous and participatory actions. Consider the example a customer meeting at the bank: The clerk has his or her agenda to make the customer profitable and acts on information not known to the customer. At the same time, he or she also cooperates with the customer to achieve joint goals. The customer on the other hand may be taking notes to compare interests between different banks. However, at any time the customer may include some of the private information in their conversation, for example, the interests given to him or her from another bank. They also strive to be polite to each other do not wish to impede on the other's autonomy, they wish the other to feel comfortable, and do not want to tear down the other's self-image. Four forces in this situation (participation, autonomy, extemporaneity and politeness) are described below.

Participation. People who are co-present in a situation of use have some projects that they do together. Sometimes the projects are small, like a greeting for instance, and sometimes they are bigger, like watching television together. These projects have shared motives, shared objects and shared representations. In order to work on these shared objects, participants need to establish common ground and to maintain coordination (Clark & Brennan, 1991). This means that they have a shared view on what they mean by different terms, what they want to achieve and how to achieve it. For that to work, they need to devote some of their attention to the other participants and what they do. The feeling of participation is also important for the individual participants and a strong incentive to participate.

Autonomy. Participants in the sociable setting have private motives and activities as well as shared motives and activities. They want to perform autonomous actions unimpeded. Individual work is performed in parallel with joint work and it is either stemming from a personal interest, from using objects as tools for one's own mind, or from private agendas.

Extemporaneity. Whenever people meet in dialogue the outcome is somewhat unpredictable and spontaneous (Clark, 1996). What previously was private may therefore, in a serendipitous interaction suddenly be needed for joint actions. Since individual and joint activities run in parallel and feed into each other an impulse that change the activity can come from any direction or any source.

Politeness. The participants in a sociable setting have a mutual wish to maintain each other's face (Goffman, 1967; Brown & Levinson, 1987). Every participant has a claim to autonomy, and do not want his or her individual actions to be impeded by others. The co-participants recognize this autonomy and do not want to hinder it. They also respect and want respect for their self-image and self-worth. Not doing so would be impolite and face threatening. Politeness is a motivating force behind all collaborative activities.

Summing up. People do things autonomously while participating in collaboration. They also think about others while performing individual actions. Some of these actions are publicly displayed so that other participants can monitor the actions peripherally and through that create an awareness of what is going on. Hindering people to do their own things or shutting them out from a joint activity can be impolite. It is quite difficult to foresee what objects participants will use for individual actions and what objects they will use for joint actions because of the extemporaneity of face-to-face conversation.

In everyday life, our focus is constantly shifting between different objects while other objects are kept in the background. When working on physical objects these shifts are managed by, for instance, moving a piece of paper 20 cm or by swivelling our chair. Managing a constantly shifting focus in the stream of everyday activities necessary for face-to-face collaboration to work (Luff, Heath & Greatbatch, 1992).

Therefore:

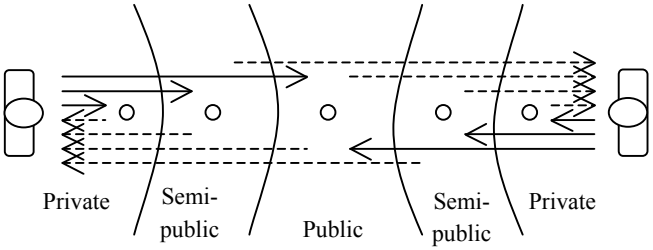

Figure 1. WORKSPACE WITH PRIVACY GRADIENT between participants in a small-group collaboration. Dashed lines indicate ability to perceive an information object and solid lines indicate ability to control an object.

Figure 2. Privacy gradient in an interaction design studio: from private (1), to semi-public (2), to public (3).

As shown in Figure 1, provide participants in small-group collaboration with workspaces where they can swiftly move information objects along a gradient of privacy. Use at least three stages on the gradient: private, semi-public and public.

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At the most private stage, individual work is performed on objects that are controlled by and prominent to one participant while being hidden to others. At the semi-public stage, individual work is performed so that others can monitor it. Work at this stage can be kept prominent in focus for the individual while being peripheral to others, who can get an awareness of it, and hence coordinate in relation to it. At the public stage, participants can work jointly on the same objects. The stages are defined by the degree control different participants have over the object, and the degree of prominence it has to different participants. The degree of control and the degree of prominence form an analogue scale that is made discrete in the three stages. A finer grained scale with more stages could accordingly be constructed. It is pivotal that objects are easily moved between the stages.

There are, around us in our everyday life, many cooperative settings that implement this pattern. The counter in a shop is one such place where some parts of the desk belong to the shop assistant and some parts belong to the customer. The spatial properties of the desk and the position of the counter provide natural surfaces for private, semi-public and public actions. We can also find it in customer meetings at banks, in studio environments, and in living rooms (Arvola, 2005). All of these situations involve physical information objects. There are, however, few computerized systems that implement WORKSPACE WITH PRIVACY GRADIENT. See for example, Figure 2 where students meet with teachers in their design studio to discuss their work: The normally private state is in this photo used for joint work, between student and teacher in a "desk crit." The workspace implements a privacy gradient, but only for physical information in the form of paper. Users cannot move information swiftly from the private workspace of the computer screen. This is why the normally private state of the personal computer is used for joint work with the design teacher. They can, however, overcome this limitation by employing suboptimal workarounds.

At customer meetings at banks, clerks use printouts or speak out what they do aloud. The person who has the remote control when surfing on interactive television also speaks out aloud what they do to make actions semi-public. Similar practices have also been identified in control rooms and also in design studios (Arvola, 2005; Garbis, 2002; Artman & Wærn, 1999; Heath & Luff, 1992; Dourish & Bellotti, 1992).

In computerized systems, one way to implement this pattern could be to utilize a single big, shared display. It would then have to have a public stage where all participants can work jointly on a PUBLIC ARTIFACT (Martin et al., 2002), as well as a semi-public stage where they can work individually on objects that are prominent to them but peripheral to others, as with an ARTIFACT AS AUDIT TRAIL (Martin et al. 2002). Such a division of the large screen can be made using TILED WORKING SURFACES (Tidwell, 1999). With a single big, shared display, private activities must be performed on the side, for example on paper. Another option for the users is to leave the shared working space to perform private activities, and this would mean that the face-to-face collaboration is broken up. This is often not desirable. A single display is hence a suboptimal solution.

It is instead likely that it takes several devices for the participants to run individual activities in parallel, using COMBINATIONS OF PERSONAL AND SHARED DEVICES. Other ways to implement the pattern could however exist. Occlusion on a digital table could, for example, be used; if the table knows where people are around it and where physical objects are on the table, it can display information so that one user can see it and not the other. This creates private stages for information on a single big screen, which otherwise only would create public and semi-public stages. One can also make use of change

blindness to display information so that only people who know what to look for can see it (Intille, 2002) . . . .

3.2 Pattern 2: COMBINATIONS OF PERSONAL AND SHARED DEVICES

. . . This pattern helps designers realize a WORKSPACE WITH PRIVACY GRADIENT in computer-based environments for face-to-face COLLABORATION IN SMALL GROUPS (Martin et al., 2002). It forms a version for face-to-face collaboration of the tentative groupware patterns SHARED WORKSPACE (Groupware-Patterns Swiki), SHARED WHITEBOARD (Groupware-Patterns Swiki), and PRIVATE WORKSPACE (Groupware-Patterns Swiki). These groupware patterns are made for geographically distributed collaboration. COMBINATIONS OF PERSONAL AND SHARED DEVICES describes means for helping users to manage their spaces for action and move objects between private, semi-public and public stages. Creating these spaces is hard to do on a desktop PC. As a workaround, users of desktop PCs often make printouts, mail files, move files to shared file servers, ask others to look away wile inputting a password, or leave the co-present situation. These workarounds are, however, too indirect and interrupt the social interaction of face-to-face meetings.

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Co-present users need to run private activities while also making the objects of their concern available to others without occupying others' whole attention if they do not want to. A good computer platform for sociable usage allows users to assign physical spaces to the different stages on the privacy gradient and provides a mechanism for moving objects between those spaces.

Users of personal technologies often meet and co-use their devices (Weilenmann, 2001), and occasionally there is some form of public device available that can be used for joint motives (such as a television screen or a monitor swivelled towards a customer). Collaboration would be of better quality if users could then easily move information objects between their personal technologies as well as to the public devices and back again. In the home, all devices such as stereos, televisions, PCs, tablet computers, etc. could be interconnected, and whenever a conflict between personal interests arises, the information object could be moved to another device. Consider a scenario where someone wants to watch a show on the television screen while someone else is in the living room listening to music. The music could then be moved to the stereo in the bedroom and the other person could go there and listen instead, or perhaps they, by a simple operation, could move it to the personal handheld music device instead. Alternatively, if someone watches a movie on a small screen in a bedroom it could easily be moved to the large screen in the living room if anyone else also wants to watch.

For interactive systems to work in COLLABORATION IN SMALL GROUPS (Martin et al., 2002) they need to provide public, semi-public and private stages, as dictated by WORKSPACE WITH PRIVACY GRADIENT. For this, a shared region must be set up, where several individuals can do things together. However, every region discloses itself for each individual and gives an individual perspective within the space. This individual perspective gives a particular predisposition to how each person can act (Arisaka, 1995). The shared region hence needs to be both personally oriented and shared. The public stage is fundamentally shared, the semi-public is shared, but also personally oriented, and the private stage is fundamentally personally oriented.

Three qualities are competing in this pattern: Personally oriented space of action, shared space of action and availability.

Personally oriented space of action. Individuals orient themselves towards the objects of their concern. These are kept physically near and within attention. The personally oriented space of action is perspectivally unique to that individual and he or she has configured the space to fit the present concerns and the things that he or she cares about. For example, the clerk in a customer meeting at the bank view, use and orient towards the table and the things on it differently than the customer does. The personally oriented space for action stretches from a private stage to a semi-public stage.

Shared space of action. People who are present in the same region share space of action. The region is defined by the activities that take place there and the resources for those activities are aligned according to them. The co-present people can refer to objects around them and hence bring them into each other's presence. The shared space for action stretches from a public stage to a semi-public stage.

Availability. People create their personally oriented space of action by bringing objects of their concern into presence. This also takes part in creating the region, which in turn dictates others' personally oriented spaces. When they share space of action these objects can be indexically referred to or signalled to others within the space, and then they are made available to others within the same space. This is an important property of a functioning semi-public stage. Objects can also be "pushed closer" (ontologically) to others and hence made more available to them. Within the shared region one can offer the other to bring something closer to them. For instance, as the clerk in a customer meeting at the bank tries to make sense of some figure he or she can invite the customer to share the information, by exploiting the micro-mobility of paper and show the customer a previously private or semi-public paper. In this way, the physical environment provides a stage for semi-public information.

Co-present users of interactive systems need a shared space of actions and a personally oriented space of action, and they also need to be able to make objects available in

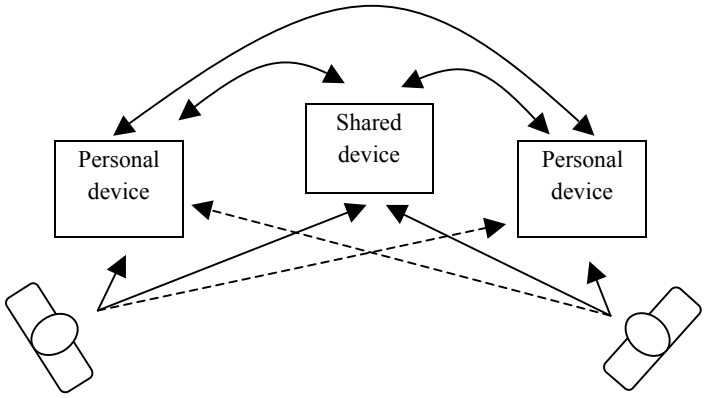

Figure 3. COMBINATIONS OF PERSONAL AND SHARED DEVICES where users have direct access to their personally oriented devices and the shared device, while only having access to others personally oriented devices when invited. Arrows between devices represent the object transfer mechanism.

their own and in others personally oriented spaces of action, without impeding on the others personally oriented spaces.

Therefore:

As shown in Figure 3, use shared devices in combination with personal devices that allows for micro-mobility and implement a direct object transfer mechanism, that easily and swiftly allow users to move objects between displays. Without such a mechanism the social interaction between people is hampered.

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Use a PUBLIC ARTIFACT (Martin et al., 2002) that always is shared for joint work and available to all participants. Active users should also have a device that is personally oriented which they can organize so it fits the things that they care about. Participants must be able to tilt or move personal devices to show information to each other. This micro-mobility allows participants to make objects more available to others without completely occupying their attention. In this way they can make use of physical space to create a semi-public stage. Inactive users do not need a device of their own. Devices must be interconnected and allow users to "throw" objects seamlessly between personal and shared devices.

Implementations of this pattern can be found in interactive spaces such as the i-Land, where computer-augmented furniture like the Dynawall, the Commchair, and the Interactable have been tested (Streitz et al., 1999). The i-Land environment uses furniture to create both private and public spaces, how semi-public work is managed is less clear. Another project that implements the pattern is the Bluespace workspace (Lai et al., 2002), which provides users with a number of different screens and display surfaces, including an Everywhere Display projector, which allow users to display graphics on any surface of their

Figure 4. A computer game platform making use of COMBINATIONS OF PERSONAL AND SHARED DEVICES.

choice. The Design Conference Room, Collaborative Classroom and Reconfigurable Collaboration Network (Geisler et al., 1999) also implements the pattern, and so does the i-Lounge (Sundholm, Artman & Ramberg, 2004), which is an interactive design studio with wall-sized public displays, digital tables and private workstations. Figure 4 depicts a prototype game platform utilizing multiple devices to create private, semi-public and public states.

The tablet computer holds the public states and the handheld computers hold the private states. Information can be made semi-public either by tilting the handheld device towards the other player. Such a game platform creates opportunities for creating social computer games based on hidden information. (Arvola, 2005)

How to allow users to seamlessly move objects between devices is a highly important issue. The interaction technique called "stitching" (Hinckley, Ramos, Guimbretiere, Baudisch, and Smith, 2004) allows users to interconnect multiple devices. By using stitching users can seamlessly move objects between tablet PCs by selecting an object and making a continuous pen gesture from one tablet to another. This works as a variant of the pattern named GO CONNECTOR (see Arvola, (2005)). Alternatively a connection can be set up between two devices in the form of a DROP CONNECTOR, which the inventors of stitching call "a transporter".

Just like stitching, the Pick-and-Drop technique developed by Rekimoto (1998) can also be useful when users are at arms length from other devices. When users are at greater distance from the device they want to move an object to, a DROP CONNECTOR, a GO CONNECTOR (Arvola, 2005) or a SEND CONNECTOR (Arvola, 2005) can present that functionality to users. Consider also implementing an ad-hoc network where wireless devices that users carry with them can be integrated into the network as they come into range . . . .

3.3 Pattern 3: DROP CONNECTOR

. . . within network of interconnected devices—for example COMBINATIONS OF MOBILE AND STATIONARY

DEVICES—users sometimes need to move objects between nodes in that network. This user interface pattern can be used when the device, through which the user acts, has a screen of reasonable resolution and size and where they can make use of drag and drop.

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When users need to move information objects between devices they need to do so swiftly and seamlessly.

Swiftness. Users need to move objects swiftly in order to make use of it serendipitously and extemporaneously.

Seamlessness. Users need to move objects without perceptual seams. It should not be an activity in its own to move an object.

Personally oriented space of action: User may use very different devices within the peer-to-peer network.

Platform independence. Devices in a peer-to-peer network may have different operating systems.

Take instant messengers like MSN Messenger and ICQ for example. Users often use these peer-to-peer networks to transfer files and links to each other. The same program exists on several operating systems and several different kinds of clients can be on the same network. It is, however, common that a user on one kind of a platform cannot transfer files to users on other platforms. He or she then instead has to send it by email or upload it to a public website in order to share it. This is a source of great frustration.

Therefore:

As shown in Figure 5, make a drop connector where users can drag and drop information objects to graphical representations of the other devices at which it appears on the displays of the chosen device. Make a component for the graphical interface that is separated from the distributed event manager and also separated from the operating system, so that it can be easily ported to other clients located on other types of devices.

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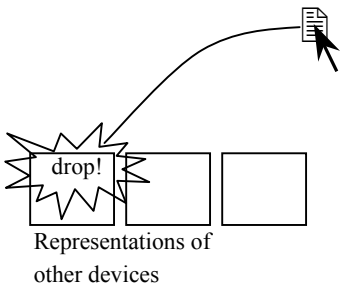

Figure 5. DROP CONNECTOR where a user drags an information object and drops it on some graphical representations of the other devices in the network.

In order to realize this pattern, the platform must be able handle drag and drop events. Make sure that the drop area representing the other devices are easy to hit when dragging an object to it. Consider highlighting it when the mouse enters the area using ROLLOVER EFFECTS (Tidwell, 2004) so that a user immediately recognizes that the mouse is over that specific drop area. Provide feedback on the progress of the transfer of objects, using PROGRESS INDICATOR (Tidwell, 2004) or PROGRESS (van Welie, 2004) . . . .

3.3 Putting the patterns to use

The patterns presented above can be realized in many different ways, but one way they can be implemented in a design is illustrated here. The Locomotion system is a multimedia home platform based on the following patterns:

- COLLABORATION IN SMALL GROUPS (Martin et al., 2002)
- WORKSPACE WITH PRIVACY GRADIENT
- PUBLIC ARTIFACT (Martin et al., 2002)
- COMBINATIONS OF PERSONAL AND SHARED DEVICES
- DROP CONNECTOR

Locomotion is based on two interconnected tablet computers and a PC with a large plasma screen, but other devices like mobile phones, handheld computers, personal video recorders and home-PCs can easily be integrated into the network. Users can move objects between the devices by a simple drag and drop. A user can tilt the tablet and make it semi-public to the other in order not to not interrupt the others activities. An object can be dropped on the drop-area for the plasma screen if a user wants to make an object completely public to the other. If one would want to make it fully available to the other and also interrupt the others activity one can drop it on the other's tablet. Finally, if a user wants to keep something hidden, the tablet can be tilted so that others cannot see the screen (see Figure 6).

Locomotion is a distributed system consisting of two major sub-components; (1) a distributed event manager that allows system events to be transferred between devices over the network, and (2) a graphical system for representing the different devices connected together (see Figure 7). It is built as a peer-to-peer system with no central server and this makes it easily adaptable to an ad-hoc network.

4 DISCUSSION

The design patterns for controlling visibility in sociable use illustrate that the desirable use qualities in a design situation can be viewed as forces. At some times these forces are in potential conflict and solutions to them can then be identified by comparing the conflict situations with the non-conflict situations in order to identify features that exist in the latter but not in the former. A design pattern can then be

Figure 6. The current version of Locomotion consists of two tablet computers and a PC with a plasma screen connected over the network.

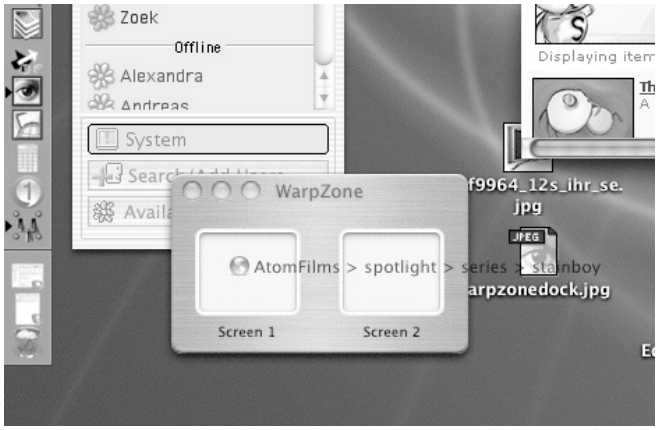

Figure 7. The user interface for Locomotion with a drop connector in the form of a floater that can be docked and auto-hidden.

established if similar features are present in several of the situations where the forces are not in conflict.

Traditional qualitative research methods can be used to identify forces in the form of desirable use qualities. This means that field studies and methods of analysis like concentration and categorization, can be used as empirical ground in the development of meaningful design patterns in HCI and CSCW. This approach to documenting design knowledge fits well with developments in ethnographically informed design (e.g. Hughes, King, Rodden & Andersen, 1994).

As in all qualitative research, theory plays an important role. Theory helps the observer direct the seeing and also to categorize what is seen. This is true also when developing design patterns. In the three patterns described here, there are references to face management, phenomenology, mediation and activity theory. All of these theories were crucial for identifying the conflicts in desirable use qualities, which formed the basis for the problem formulations in the design patterns. This implies that social and behavioural studies are important part of the training of interaction designers, if we want them to document and articulate their design knowledge using patterns.

4.1 Levels of interaction design patterns

In activity theory three levels of action are conceptualized: activities, actions and operations (Leontiev, 1978; Kuutti, 1996; Bødker, 1989, 1996). For interaction design, these three levels also emerge as objects for design (Arvola, 2005).

Looking back at the three design patterns for controlling information visibility in co-located collaboration, we see that they are of three kinds. Firstly, WORKSPACE WITH PRIVACY GRADIENT describes an environment for interaction: it describes a feature needed in any physical or computer-based workplace for co-located collaboration. Here, interaction design meets interior and workplace design. Secondly, COMBINATIONS OF PERSONAL AND SHARED DEVICES describes means for interaction between people: it explains the setup needed for computer-mediated collaborative face-to-face interaction. Thirdly, the DROP CONNECTOR describes an interface for interaction. This is area of graphical user interface design. All three of these objects for design correspond to three loops of interaction depicted in Figure 8.

The first loop is the interaction between user and computer application. The second loop is between the user and the material that is being manipulated by means of the application, for example, data in a database, or a pixel-based image in a photo editor, or joint objects on a multiple-device platform. The third loop is between the user and other people involved in the same environment, where the materials and applications are used to mediate the activity. Interaction design is the design of interaction in all three of these loops.

Locating the three patterns described here on the levels of activity theory, the WORKSPACE WITH PRIVACY GRADIENT would be located on the level of activity. The reason is that the gradient is there in workplaces in order to fulfil the purpose of creating the experience of sharing while working individually, and it is driven by motives like autonomy, participation and politeness. COMBINATIONS OF PERSONAL AND SHARED DEVICES would be located on an action level, since it describes a solution to a problem of how to move objects between spaces of action. Moving objects is a conscious action. For an expert user, the DROP CONNECTOR will become operationalized from

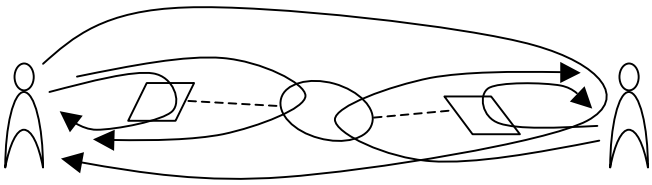

Figure 8. Three loops of interaction; the interaction with an interface, through some means and within an environment.

action level to operation level as a consequence of learning. Accordingly the DROP CONNECTOR could be either at the level of action or at the level of operations. At an even lower level there would be patterns for basic interaction designs on graphical user interfaces such as drag-and-drop, click, double-click and mouse-over.

We see from this analysis a multi-level structure of interaction design emerging. The levels can be connected to van Welie's and van der Veer's model (van Welies & van der Veer, 2003). At the highest contextual level in their model are the business goals. This is a matter of designing organisation, roles, regulations, and strategies. These are usually not thought of as belonging to interaction design but their definition affects what interaction designers design. At the level of posture as defined by van Welie and van der Veer, the kind of product and its overarching character is defined (e.g. portal, community site, e-commerce, tool, 1-to-1 medium). At this level, the conceptual interaction design takes place. The level of experience is where personal high-level goals of users are to be met (e.g. shopping, sharing, browsing, creating). Both on the level of posture and the level of experience it is vital to consider the design of the environment for interaction. This is where the design of workplaces meets the interaction design. The physical properties and layout of things in space structure what kinds of systems (postures) should be designed and what experiences the use of the systems contribute to (e.g. without WORKSPACE WITH PRIVACY GRADIENT there will be a disrupted experience of sharing). At the level of tasks, where higher-level goals are broken down to lower-level goals, the structure of interaction and navigation is decided upon in terms of sequences of interactions performed in order to reach the higher-level goals of experiences. Deciding on means for interaction (e.g. COMBINATIONS OF PERSONAL AND PUBLIC DEVICES) is at the level of tasks since, the means decides what interactions can be performed and what interactions that cannot be performed. The lowest level of interaction design in van Welie's and van der Veer's model is the level of actions. This is where objects belonging to the interface for interaction are, pushbuttons to press, and image wells to drop things on. The structure and flow of the interface for interaction belong however to the level of tasks.

4.2 Design patterns and the particularity of design situations

A problem when generalizing over three very different cases to create a generic design pattern is that there is a risk of creating a vague pattern since it becomes unspecific due to loss of detail. Design situations are unique situations and patterns should therefore be used with some care in a design process; contextual factors may have a very large impact on which design solutions that are appropriate.

Given that every new design situation is particular and unique, generalized design solutions as patterns that are documented to have worked in other design situations may sound as a futile approach. This is, however, not the case. Studying earlier designs that have been documented in patterns help a designer become aware of specific qualities and judgments that need to be addressed in the unique design situation. An immersion in past design projects and helps a designer create a sensibility and appreciation in their composition of a new particular design, but it does not provide pat answers for future designs (Nelson & Stolterman, 2003).

A pattern is a formalized version of an ideal solution that can resolve the tensions of that-which-is-desired (the desideratum). Whenever such tensions occur in a design situation the patterns should be able to provide a designer with inspiration and appreciation as well as sensitizing him or her to the qualities of the design situation. By being uncommitted to details, design patterns have the potential to open up a space of possibilities rather than pre-maturely constraining the design to a single solution.

4.3 Future Research

When it comes to the methodology of putting design patterns to use in interaction design, there is still much research that remains. There is, for example, a large potential for scenarios to be used when describing forces in design patterns to make patterns and especially the conflicting forces come alive for a design team and other stakeholders. It also seems appropriate to relate the claims analysis in scenario-based design (Rosson & Carroll, 1995) to the desirable use qualities in the situation, and hence to the forces in a design pattern. Another direction for future research is to look into the efficacy of interaction design patterns on design work in both educational and professional settings.

4.4 Conclusions

Four use qualities were identified as critical to design for in sociable situations: *participation*, *autonomy*, *extemporaneity*, and *politeness*. Users need to be able to control the visibility of information and this can be achieved by implementing the design patterns WORKSPACE WITH PRIVACY GRADIENT, COMBINATIONS OF PERSONAL AND SHARED DEVICES, and DROP CONNECTOR.

Desirable use qualities can be used as forces in design patterns, which means that traditional qualitative research is highly valuable when documenting design knowledge in patterns. As in all qualitative research, behavioural, psychological and social theory plays an important role when identifying and developing design patterns for interaction design.

Design patterns for HCI, CSCW and interaction design can be described on multiple levels. The classification of patterns as describing environments for interaction, means for interaction, and interfaces for interaction, provides a terminology for identifying, articulating and communicating types of patterns located within the levels of business goals, postures, experiences, tasks and actions. There are,

however, no obvious seams between these abstraction levels, and some interaction design patterns may exist between two levels.

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