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Erotic Aspects of Everyday Life as a Challenge for Ubiquitous Computing

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ABSTRACT
In this paper we discuss how interactive technology disables or enables erotic aspects of everyday life, and we discuss a number of design concepts in order to relate erotic aspects to the issue of visibility versus invisibility in ambient computing. This discussion has general relevance for the study of residual categories in ubiquitous computing.

INTRODUCTION
It can be argued that HCI is experiencing an aesthetic turn these years (Udsen & Jørgensen 2005). It seems that this turn is not only motivated by the fact that HCI is becoming relevant in new settings like home and entertainment, but likewise in theoretical need to understand the dynamics of the use situation (Bolter & Gromala 2006; Bertelsen 2006).

Since the seventies technical rationality has been considered problematic if applied as the only principle in the design of information technology. It does seem clear, also, that the rather clear focus on purposefulness and goal direction, prevalent in most HCI until now, may be limiting. Indeed, it can be argued that HCI at large, including PD, CSCW etc., is penetrated by a kind of technical rationality thus marginalizing many facets of human life to become residual categories (Beck 2002).

Thus, the potential reorientation instantiated in the aesthetic turn is one that breaks fundamentally with the hegemonic status of technical rationality. As an example of a residual category this paper looks into the interplay between information technology and erotic aspects of everyday life.

IT AND THE EROTIC ASPECTS OF EVERYDAY LIFE
Television is an obvious example of a technology that can be both a disabler and an enabler depending on the situation of use. A recent study (Politiken, 16 September 2006) has suggested that TV in the bedroom reduces the sexual activities; at the same time many couples with small children tell that TV-programs for children in Sunday mornings have been an important help for maintaining sexual activity. A similar duality might be in play with respect to cell phone text messaging. On the one hand the constant availability to people from outside, e.g. the workplace, may disrupt intimacy; on the other hand the option to exchange erotic messages during the workday may be a turn on.

We suggest that technologies in the home setting (and elsewhere) in relation erotic life can be analyzed in terms of a tension between being *enablers* and *disablers*. The table below indicates a first step in such an analysis of technology influenced erotic life.

	Disablers	Enablers
Sexual intercourse	TV in the bed room	Sunday morning TV for kids.
Kissing/caressing		
Flirting	Continuous stream of work related emails	SMS messages
Erotic atmosphere		

Table 1: first attempt on a classification of disabler and enablers.

Most approaches to technology mediated erotic activity in the past seem to have centered around futuristic concepts such as cyber sex, where sexual activities would be carried out in virtual reality with the users hooked up via direct stimulation of erogenous zones. In contrast, we aim to look into the erotic, and sexual practice, as examples of aspects of life not directly designed for in the development of information technology, but still changed massively with ubiquitous computing, i.e. as technology is becoming present in the private and intimate sphere. Sometimes the effects of the new technologies are positive, but most often it seems that the effect of these workplace centric technologies invading private life is that intimacy is jeopardized. In particular, it is rarely an issue of debate or concern how a new ubiquitous computing technology influence erotic aspects of everyday life. This is a problem, as it seems to be the case that many of the new technologies entering into the private space (in combination with an intensified working life) are significant factors in making sexual life difficult for many couples today. In particular some of the technologies existing, or being introduced or inserted into, the home setting contribute to a reduction of erotic space.

Technologies in the home develop at a high pace. Therefore, a counter discourse is needed – a discourse focusing on technologies and aspects of technologies that can reopen the erotic space in the home. The aim of this paper is to begin this discourse. The phenomena we focus on are in a spectrum from the erotic atmosphere (or ambience) via the light flirt, to the concrete conditions for realizing the sexual intercourse.

EROTICISM AS AN ANALYTICAL CATEGORY

The erotic dimension is characterized by immediacy, un-mediatedness, and it seems to be opposed to the hermeneutic in large parts of aesthetic theory (e.g. Breinbjerg 2003). The eroticism is before and beyond rhetoric, interpretation, representation etc.

In relation to the concept of ubiquitous computing, eroticism is particularly interesting. The erotic moment is defined almost paradigmatically in Baudelaire's poem to the women that passes by (1857), what is interesting about this moment is that it is an instant reconfiguration of the two involved people, but also to some extend of the entire situation. The erotic glance is out in the open, to be seen by anyone, but only perceivable for the relevant other person. Thus, the play between visibility and invisibility is fundamental in erotic action. The interesting point to note here is that this same tension between visibility and invisibility seems to be fundamental in ambient computing.

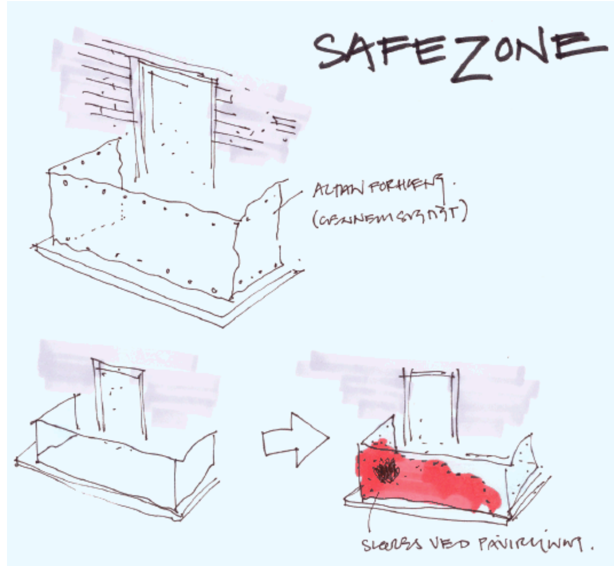
EROTIC DESIGN CONCEPTS

To further the idea and investigate into the specifics of supporting erotic aspects of everyday life, we organized a workshop where we invited a number of students to brainstorm with us around concrete design concepts that exemplifies how it is possible to exploit ubiquitous computing technology to design specifically for erotic experiences in everyday life. Interestingly, a number of the concepts centers around and play with the dimension of visibility and invisibility. Below we present a number of design concepts that emerged at the workshop.

As suggested in table 1, designing for erotic experiences embraces a range of situations ranging from designing means for building erotic atmosphere to designing for sexual intercourse. *Inside out* in a way helps construct an atmosphere and expectations while *GPS Pleasure Zones* offer new ways of caressing in the form of erotic stimuli, where *SafeZone* offers new settings for sexual intercourse. The concepts are not polished, finalized design concepts but they help depict the landscape of designing for erotic experiences in everyday life.

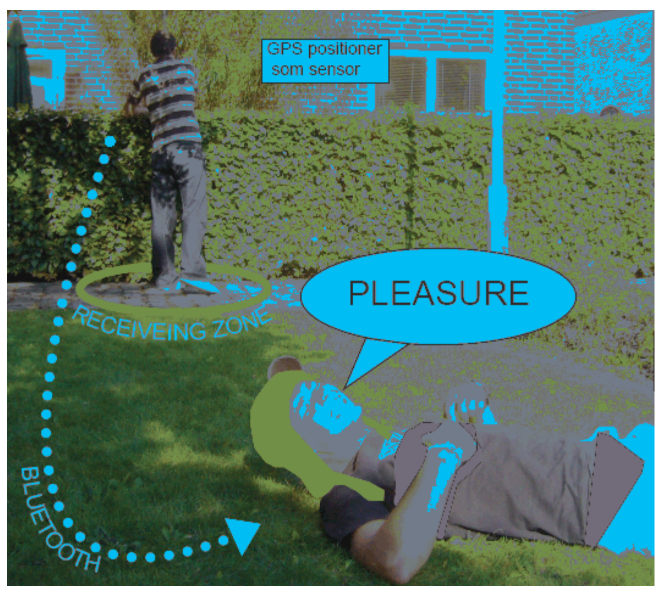
SafeZone

SafeZone is a concept that turns an otherwise public space of a balcony into a more private space and therefore creates a new room for intimate relationships. At the same time as it also plays with the excitement of exposing aspects of erotic activity in public. The idea is to have movement- and heat sensors register activity on a balcony and correspondingly turn an otherwise transparent shield into a cover where invisible areas are created, even though the contours of these suggest that something is going on.



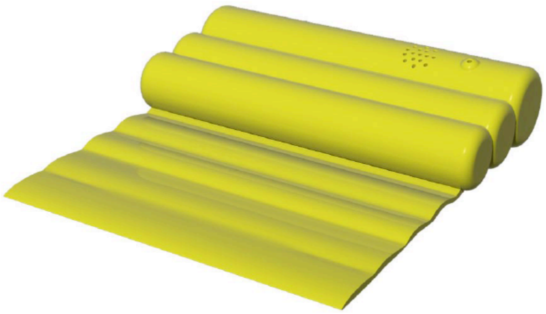
GPS Pleasure Zones

GPS Pleasure Zones is a concept that allows a couple to erotically stimulate one another while doing gardening at home. When one person moves to a specific place in the garden an actuator embedded in the other person's underwear is triggered and starts to vibrate, become warm, cool or invokes other stimuli. Different places in the garden invoke different stimuli. To by passers, this may look like ordinary gardening, however, to the involved couple, a new dimension has been added to gardening work.



Inside Out

Inside Out is a concept that seeks to make it easier for lovers to share erotic fantasies. Fantasies can be sent (by mobile phone) or whispered directly to the inflatable mattress which expands in response to the number of fantasies currently awaiting revelation. The fantasies are visible and invisible at the same time. They are a secret layer of mundane furniture, which are only shared between the lovers, but at the same time manifest in physical space.



VISIBILITY AND INVISIBILITY

The EU/IST call on ambient intelligence positioned invisibility as a key factor in truly ambient technology; the rationale being that with myriads of devises, components, etc it is required that the technology minds itself without users' intervention. The Palcom project (Palcom) has set out from the assumption that technology that just does its' thing independently of users control will not work properly in non-standard situations because in those situations no formal rules exist. Hence, the concept of palpability is based on a number of challenges formed around negations of the original aspects of ambient computing, among which the challenge of making systems that provide invisibility with visibility is key. This tension is an important part of the concept of palpability that the IST Palcom has introduced (Palcom). As the Palcom project primarily focuses on architectures for ambient, or palpable computing they take the visibility-invisibility tension in a quite literal and technical meaning.

The visibility–invisibility tension is not, however, only a technical issue but also, and maybe more interestingly, a personal and relational issue.

One of the concepts developed in the Palcom project is an incubator. Besides addressing physical and medical issues that are directly important for the survival of the early born child, it also addresses the issue of various sensors being perceived differently by doctors and parents, and the need for gradual unpacking of the child not matching the parents' expectations (Grönvall et al. 2005). The various actors taking part in the recovery of the early born child have different perspectives and expectations that determine what is visible for them. In this way visibility is closely linked to the dynamics between perception and action.

The design concepts from the erotic workshop address the visibility – invisibility tension in different ways.

SafeZone play with visibility-invisibility by revealing more or less of the action at the balcony to the possible spectators outside. This is has similarity to some of the technical considerations related to ambient computing; how much of the continuous re-configuration should be visible to the user. The difference is, however, that in the ambient computing situation the user in focus is the one who can see more or less whereas in the *SafeZone* the user is the couple at the balcony and the people outside, the ones who can see more or less, are accessories to the erotic experience.

The *GPS Pleasure Zones* concept plays with visibility-invisibility by placing the actors in the public, fully visible, but with the sexual stimulation as such being completely invisible. Thus, the concept enables the couple to engage in an erotic activity that only they know about even though it goes on in public space. The concept provides intriguing possibilities for erotic play and exploration of stimuli. While the *GPS Pleasure Zone* hides the stimuli for the public it maintains the non-technical tension of the erotic connection between being visible only for those involved. In that way, the concept points back to an important aspect of erotic life that is difficult to formalize. The possibility of disclosing or not disclosing the erotic tension is not addressed by the concept, but stays intact compared to the situation where the couple, without technical equipment is together in public space. In a curious way, the *GPS Pleasure Zone* brutally reduces erotic interaction to mere physical stimulation at the same time at it does not change erotic play itself. Generalized as a design strategy, this means that some aspects of the activity being supported is systematically kept out.

The *Inside Out* concept deals with the visibility – invisibility dynamics in a more sophisticated way. Anybody entering the room will be able to see the entire artefact and the state it is in. The meaning of the more or less inflated piece of furniture, however, remains a part of the exclusive intimacy between the couple. Only the lovers have access to the messages stored in the furniture. At the same time other people using the room, will observe changes in the state of the artefact and they might be able to couple those changes to their current experience of the couple. This is an example of visibility-invisibility being related to purpose and interpretation. For the "ordinary users" of the room, those who are not part of the couple, the changes do not disturb whereas these same changes are strong signals for the couple. In terms of a design strategy, the *Inside Out* concept points to simplicity and ambiguity. Interestingly, the *Inside*

Out concept is the only clear enabler among the three concepts described, in particular in relation to creating an erotic atmosphere.

DISCUSSION

Our starting point was that the erotic life is under pressure by modern technology because it has become a residual category as technical rationality takes command. By supplementing the analysis of technology as being enablers or disablers with the invisibility with visibility challenge we have looked into three design concepts addressing erotic life in the home.

The three design concepts all aim to be enablers, but they do so in different ways. The *SafeZone* and the *GPS Pleasure Zone* create a playground for shifting back and forth and balancing between visibility and invisibility in the sexual play. In this way the two concepts are enhancers of an ongoing game rather than enablers as such. In contrast the *Inside Out* concept enables the creation of erotic atmosphere, and provides a new space for building intimate communication. Thus, only the *Inside Out* concept effectively contributes to the counter discourse we were asking for earlier in this paper.

The important aspect of the invisibility with visibility challenge in the context of erotic everyday life is not about exhibitionism and voyeurism, but about enabling intimacy, privacy, and exclusivity together with open production of meaning.

In order to take this study further we intend to look into empirical surveys of the effect of contemporary society and technology on erotic life. On this basis we hope to be able to develop concrete prototypes that can be evaluated. Complemented with a further study of residual categories in general we expect to be able to formulate the design oriented counter discourse.

ACKNOWLEDGMENTS

The concept workshop was organized in collaboration with Sofie Beck. We would like to thank Karin Lønstrup, Lene Normann Pedersen, Kim Sonnich Østergaard, Rune, Kasper, and Klaus for letting us use details of their design concepts in the paper. Also thanks to Lone Kofoed for fruitful discussions.

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Seamless Cross-Application Workflow Support by User Interface Fusion

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ABSTRACT

In a mobile and ubiquitous computing environment, it becomes evident that users perceive tasks not as connected to some specific application, but rather to some special context. Consequently, borders between applications providing distinct features are blurred and programs need to be interwoven. Features belonging to the same task or workflow need to be presented together. This presentation depends on the current application and user context, but also on the capabilities and constraints of the execution environment. In a ubiquitous computing environment, devices differ in display capabilities, input-output-interactions and user habits. This paper identifies the problem of disruptive cross-application workflows in ubiquitous computing and proposes dynamic user interface fusion to support the user in handling such workflows. In addition, a framework for dynamic user interface fusion is proposed.

Categories and Subject Descriptors

H.5.2 [**User Interfaces**]: Graphical user interfaces (GUI); C.5.3 [**Microcomputers**]: Portable devices; H.5.2 [**User Interfaces**]: User interface management systems (UIMS); H.5.2 [**User Interfaces**]: Theory and methods; H.5.2 [**User Interfaces**]: Screen design

General Terms

Algorithms, Design, Human Factors

1. INTRODUCTION AND MOTIVATON

Many every-day scenarios of utilizing a desktop or hand-held computer involve *cross-application workflows* that require the use of a variety of different programs in order to fulfil a given task. For instance, answering an e-mail request for the results of the recently organized conference might need access to various information sources, use of different programs to integrate the data and compile a set of concise charts, access to the address book for locating the addresses of people who should also be informed and finally return to the e-mail reader for answering the request with the compiled information.

The effectiveness of such cross-application workflows strongly depends on the ability to preserve as much as possible the relevant information of the working context when switching programs. On classical desktop computers this is not difficult. Their screen size allows users to arrange the windows of different applications next to each other or slightly overlapping so that all relevant information can still remain in view and directly accessible (see figure 1(a)).

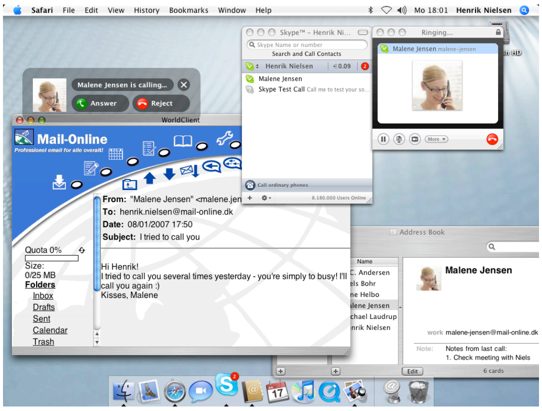
On a mobile device, the situation is radically different. Display resources and user interaction options are typically very limited. Therefore, current mobile operating systems tend to display only the user interface of the focus application, ignoring other applications which might be relevant to the current workflow (see figure 1(b)). We call this behaviour *greedy screen allocation*. Greedy screen allocation disrupts the user's perception of information and actions relevant to her working context. In order to find again the hidden information the user is forced to switch to another application, losing the user interface of her primary application (e.g. the phone controls) out of sight.

The disruption caused by greedy screen allocation is particularly annoying when the screen is 'wasted' on an application displaying interface elements that are not relevant to a working context. This occurs rather often, since typically, user interfaces of classical applications provide access to a variety of features at the same time, of which only some are really needed for a given workflow. In Figure 1(c)) we highlighted the elements that are relevant in the context in which Henrik receives a phone call from Marlene.

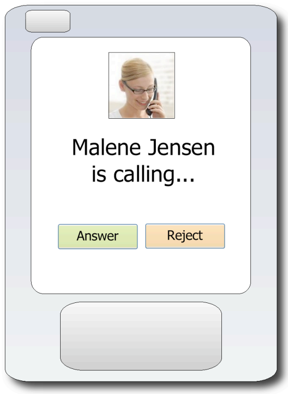
The contributions of our paper are

- identification of the problem of disruptive cross-application workflows in ubiquitous computing,
- the proposal of dynamic user interface fusion to supporting seamless cross-application workflows,
- identification of technical challenges for interface fusion not solved by existing approaches,
- a review of supporting techniques possibly applicable in this area.

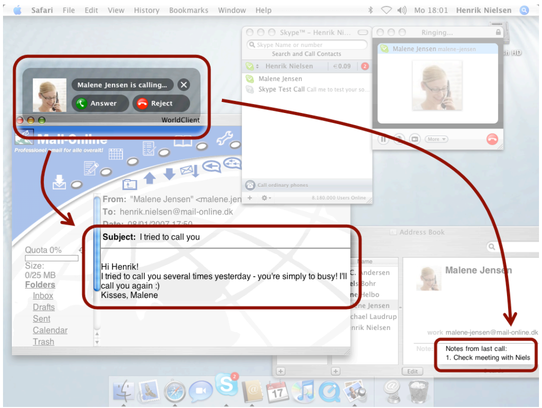
Workshop on Multiple and Ubiquitous Interaction Aarhus, Denmark, 28-30 March 2007



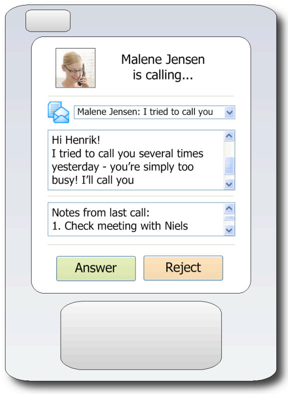
(a) Multiple applications involved in call answering



(b) Greedy screen allocation on mobile device



(c) Application-spanning dynamic context



(d) Cross-application dynamic UI fusion on a PDA

Figure 1: When an application gets the focus on a desktop computer, other applications are still visible (a). On a mobile device, just the UI of a single application is displayed at a time (b) hiding related information from other applications (c). With *display segmentation*, GUI elements of several features related to the current workflow are fused, even if provided by different information sources (d).

2. DYNAMIC USER INTERFACE FUSION

In order to support seamless cross-application workflows even on resource-constrained mobile devices, the computing system should be able to provide a task-oriented user interface that blurs the borders between different programs.

The idea of *dynamic user interface fusion* is to automatically compose the user interfaces of the features required in a particular working context, independent of the feature provider. A feature provider can be a single program, several concurrently running applications on the mobile device, unanticipated program adaptations [10] or independent services distributed in a Pervasive Service Environment [3].

The simplest case of dynamic user interface fusion is *display segmentation*: A *working context* defines several features that are important for the current workflow, so interfaces for these features need to be rendered together. Scenarios that call for *display segmentation* are:

- *Incoming phone call* (see Figure 1): On a smart phone, information about the caller (name, recent contacts, etc.) could be displayed next to the incoming call notification. Having related information in view can ease the user's decision whether to accept the call.

- *Shared use of embedded displays:* Ubiquitous computing seamlessly integrates into the users device environment, which imposes the possibility to share visualization devices for different features: A body sensor could enhance a smart wristwatch with a health checking feature, which is displayed alongside to the watch's main function.

An example of more complex interface fusion is *UI element sharing*, which means that different features share the screen area and functionality of a particular interface element. This could be the case with a *location driven information manager:* Based on the current user location, personal information coming from different programs (such as bookmarks and notes) are displayed in a common control, e. g. a listbox. In [10], we examine the use case of visiting a trade fair. When approaching a specific stall, the relevant data from unconnected sources is displayed together to support an upcoming business meeting.

3. APPROACHING DYNAMIC USER INTERFACE FUSION

Context based dynamic user interface fusion raises several challenges: identifying available features of concurrently running applications, extracting their interface elements relevant in a certain context, re-arranging them while balancing their competing requirements and achieving device constrained interface rendering in a flexible and portable and way.

Feature-identification and extraction requires semantical knowledge of application- or service-provided features and their user interfaces. A dynamic rendering of user interfaces against diverse and changing display parameters as well requires knowledge of the display element's meaning. This correlation motivates the use of model-based or semantical interface descriptions.

Model-based or semantical interface definitions prescind from the concrete interface representation on a given device in favor of a meta-description of the user interface (see e. g. [5, 12]). In our approach, sketched in Figure 2, it is the task of the *feature providers* to describe semantically every available feature and its user interfaces. These descriptions may evolve and change over time as the user interacts with the described features and external context changes can trigger feature adaptation (and therefore UI adaptation).

The described interface elements are put into mutual relationship with each other by the *Context-Aware Interface Decorator*, based on the current execution context. This context, provided by a separate *context provider*, comprises the current user task and external parameters. The context and the identified semantic relationships between elements are themselves parameters for a priorization of the interface elements.

The semantic description of the available interfaces, decorated with relationship and priority information, is the input for a *Semantical Interface Layout Engine*. It is the task of this engine to render the actual device's user interface taking into account device-specific constraints. Devices in mobile and ubiquitous computing differ in physical capabilities such as screen size and resolution, single or multiple output devices, and different interaction-patterns such as multi-touch, pen-input, etc. This may result in very different layouts for the same fused user interface. The layout of one particular interface can even change dynamically triggered by changes of the display environment when applications migrate from one device to another or new visualization devices become available. For instance, a phone application might display contact information about an incoming call on the user's wristwatch when the mobile phone's display is covered.

For automatically generated user interfaces, well-established design and usability guidelines [7] need to be taken into account. Ubiquitous and mobile computing challenges those well established rules and guidelines with new requirements [2]. The specific solutions for ubiquitous interaction interfaces are still under research.

In the next section we review know approaches that can contribute to meeting these challenges.

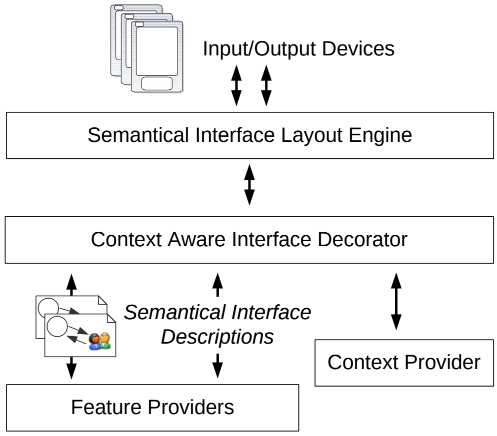


Figure 2: Semantical descriptions of the user interfaces of application's features are mutually related and prioritized based on the current context before rendered as actual user interface.

4. RELATED WORK

Different approaches for dynamic user interface adaptation have been proposed based on models such as roles and tasks [13, 12], data input- and output flows and annotations [11], or visual component composition [18]. These approaches adopt an application-based view and do not yet take cross-application interface fusion into account.

Fine-grained adaptability of interfaces is the research aim on plasticity of user interfaces, as described for example in [17]. Bisignano et al. [4] sketch a framework for adapting user interfaces on devices for ubiquitous computing. The authors adapt the GUI and the displayed content but also focus only on single applications and do not take the whole collection of features provided by different applications on pervasive devices into account. Another approach for interface adaptation, described in [15], uses the AMF interaction model in order to deduct requirements from Abstract Interaction Objects.

A number of abstract interface definition languages and interpreters have been proposed in the last years. Recent developments are XIML [14] and UsiXML [9]. *XIML* is one of the few abstract interface languages considering a "dynamic presentation reorganization". The authors show that dynamic adaptation of an abstract interface element is possible by mapping it to different representations. However, the idea seems to be discontinued and no framework for complex application interface adaptation was proposed. In continuation of XIML *UsiXML* was developped. This language supports different levels of detail (Task & Concept, Abstract User Interface, Concrete User Interface, Final User Interface). The TransformiXML-Tool [16] supports rule based transformations between the different abstraction layers. For supporting interface reuse Lepreux [8] provides a theoretical foundation for merging existing GUI layouts statically.

The Apple iPhone [1] supports display segmentation at a very basic level, e. g. ongoing phone calls are visualized while searching for related documents. Whereas this device marks a milestone in mobile UI development, its visual and computational interlocking of independent applications seems not to be context-driven, yet.

Relationship derivation based on current context such as time, location, or any other sensor data has been researched for several years now, paralleled by approaches to reflect this in the user interface [6].

5. SUMMARY AND OUTLOOK

In this paper, we addressed the problem of supporting seamless cross-application workflows in ubiquitous computing with adequate user interfaces. As a solution, we proposed *dynamic, context-driven fusion* of features from independent applications or service providers. Dynamic interface fusion integrates independent interface elements into one consistent user interface if the provided features are semantically related. The fused interface is rendered depending on the *physical device constraints*, which might change dynamically if displays are exchanged or applications migrate to other devices. As a first attempt to support dynamic interface fusion we presented a *layered architecture* that separates Interface Element Providers (e. g. applications, pervasive services), context providers, a Context-Aware Interface Decorator, and an Semantical Interface Layout Engine.

Our next step will be an in-depth research of the options for implementing each proposed architecture component. In parallel with solving technical issues, the interaction of users with fused interfaces has to be evaluated in practical scenarios. Enhancements in usability can lead to a more natural interaction with the computing device compared to today's disruptive patterns. This shift represents an important step towards seamless ubiquitous computing and defines therefore a central requirement of next generation computing research.

6. ACKNOWLEDGEMENTS

This reserach work is part of the Context Sensitive Intelligence (CSI) project under the direction of Armin B. Cremers and Holger Mügge. The project is financially and conceptionally supported by the Deutsche Telekom Laboratories (T-Labs, http://www.deutsche-telekom-laboratories.de).

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A topic categorization approach for understanding IM activities on the Web

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ABSTRACT
This paper focuses on analyzing recorded chat logs and collaboration activities among 4 scientists coming from different scientific fields and nationality. Their communications were facilitated by the Web medium in particular using the BuddySpace instant messaging (IM). The recorded chat logs allowed a qualitative and semantic analysis of the conversations. The aim of the work is to evaluate tool performance through analyzing pause situations. We introduce a general method to analyze conversations in relationship to tool evaluation. The results obtained showed that the lack of understanding *on the nature of work practice* of people jointly working together subject the tool to high frequent pause situations.

Author Keywords
Scientific collaboration, Work practice, Activity theory, Instant messaging.

ACM Classification Keywords
H.1.2

INTRODUCTION
In [1], the authors have proposed a novel method for analyzing communications on the Web knows as *the activity states framework*. The aim of the study was to understand how people induce communication protocols during distributed scientific collaboration [1,6] facilitated by the Web medium.

We briefly describe the background of the study. In 2003, the EleGI consortium was established, consisting of 24 partners. EleGI is abbreviated for 'European Learning Grid Infrastructure' [5]. One of its major goals is to support group working in different collaborative contexts, starting from self-organizing of online virtual communities, up to experimentation of communication and information management tools, through the progressive development of services in the context of a GRID based software architecture. The work in [1], analyzed 6 collaborators coming from Netherlands, Germany, France and Italy. These collaborators came from different scientific specialization (i.e., computer scientists, psychologists, GRID engineers) communicating on the Web. All of their communications were mediated by BuddySpace instant messaging (IM) and FlashMeeting video-conferencing [4]. Each collaborator is given a task and role. The collaborators are in preparation to start with the EleGI project by preparing a written deliverable.

In this paper, we show excerpted chat logs illustrating multi-tasking activities between two collaborators with different roles; a project coordinator and a project executive. From our hypothesis based on the observations, multi-tasking activities contributed to frequent *pause situations*[1]. From here onwards, the pause situations[2] revealed design problems in the current BuddySpace IM. The chat logs were recorded for the period of 7 months (i.e., 193 days) to evaluate the functions of the IM for the collaborators and in which context was it frequently used for. About 50,000 words were analyzed. A qualitative and semantics analysis was conducted on collected data. Hence, this paper is organized as the following; (i) analyses of particular excerpted chat logs; (ii) introduction to general method for analyzing chat logs based on *topic categorization* [2]; and finally (iv) conclusions and discussions.

WHAT CAN THE CHAT LOGS REVEAL?
In this section, we shall discuss a particular excerpted chat logs. This particular type of chat content most frequently takes place during chat activities. Firstly, BuddySpace IM was used only for 31 days (with total of 41 hours 52 minutes) out of the 193 days. The most frequent time pause occurred with the frequency of 4 times, with the average time pause of 2 minutes. The average time pause occurred with the frequency of 2 times. The initial goal of the project was to provide a quick gateway for collaborators to access

[1] A pause situation (i.e., termed as *breakdown situation* originally introduced by [11], pg.4) is any interruption in the smooth unexamined flow of action. It includes events that participants might assess as negative (as when the pen you are writing with runs out of ink) or as a positive new opportunity (e.g., a stray useful thought that interrupts your flow of writing or a friend knocking at the door).

[2] We use the term pause and breakdown situation interchangeably in this paper.

information and group members very quickly on the Web. The results of the analyses revealed that it was also mainly used for *giving effective instructions step by step* to other members (concerning the project and functionality of the tool itself). When the project involves active participation in conditions that there is a need to be actively engaged in a common activity (e.g., open, view, discuss and send documents), the nature of communication practices became more complicated. The chat lasts longer, but at certain period of time the system becomes vulnerable- perhaps *due to the nature of how users organize their multitasking activities*.

> [2004/04/19 10:38] <Executive> *just looking* at *the table* in Technical Annex v7.6, page 15
> [2004/04/19 10:38] <Coordinator> But if you are telling that this "methodology" is not going to help us at all, I am not surprised
> [2004/04/19 10:38] <Executive> *comparing* that with the *document sent last Iek*... about GQM..
> [2004/04/19 10:39] <Coordinator> I am *looking for this one*
> [2004/04/19 10:40] <Coordinator> now I have the two opened
> [2004/04/19 10:40] <Executive> yeah, *email of 8th April* "setting up the GQM"
> [2004/04/19 10:41] <Coordinator> first say what you have to do
> [2004/04/19 10:42] <Coordinator> second say how you will be sure that you have done it ..
> [2004/04/19 10:42] <Executive> sure...
> [2004/04/19 10:42] <Coordinator> I think again of the three axes ... would you like a short ".ppt" ?
> [2004/04/19 10:43] <Executive> ok
> ....(*edited*)
> [2004/04/19 10:45] <Executive> also Goal 6. Evaluation of the Contribution to the technical standards in the learning, semantic Ib and Grid domains;
> [2004/04/19 10:48] <Coordinator> I had a technical problem, so I quitted
> [2004/04/19 11:03] <Coordinator> buddy space was suddenly frozen

Refer to the chat content. Since the duty of a project coordinator is to coordinate the EleGI project and mostly assists other group members, he needed to frequently *recall point of references*. Some of the references would commonly be specific e-mails, documents, and even contacts. The discussion had to be re-initiated after 4 minutes of debugging the tool together. Unfortunately due to the breakdown situation, the executive did not managed to discuss the business goals but instead focused next on the presentation slides sent through e-mail by the coordinator. In [6], the multitasking scenario is highly reported in different literatures [3,8]. BuddySpace is normally used as a "mediator role": as a *start protocol* in achieving a certain task/goal.

How do we understand better the nature of individual work practice but jointly working together at a distance? How do we analyze their work activities? It is the objective of this paper to understand the relationship of the tool to people- how they organize and coordinate themselves over the Web medium. Hence, in section 4, we introduce a general method by [2] known as topic categorization to answer some of the questions above. But before, we discuss in brief the hypothesis of the current problem in the IM design in the next section.

PROBLEM IN CURRENT IM: HYPOTHESIS 1

In the previous section, we show an excerpted chat contents that frequently takes place during the EleGI collaboration. We discuss briefly in what nature was the BuddySpace used for. BuddySpace is normally used as a "mediator role": as a *start protocol* in achieving a certain task/goal. The discussions normally end up with video conferencing, or phone calls. A common recurrent issue such as "I'll phone you then" is grounded to this situation. Examples of other collaborative task that users need to do are like viewing documents together, are not provided. Therefore, the end of the chat is always moving from BuddySpace to another communication tool because BuddySpace does not provide this facility. However, a tool cannot provide all the facilities. Since IM is generally to provide opportunities for informal communications, it emphasizes on impromptu discussions, quick access to information and media switching [6,7,8]. However, particularly media switching may make the system more vulnerable to breakdown situations. Therefore, we hypothesize that multitasking makes the system more vulnerable. There is a relationship between the number of multi-tasking to pause frequency. *How to multitask* may save the system from becoming vulnerable. In the next subsections, we focus on how we analyze the data collected and statistically what can one find from the observations..

TOPIC CATEGORIZATIONS

Topic categorization is a general approach originally formulated by [2] to understand from recorded utterances, statistically significant patterns [3]. We have adapted this general method to our contexts of work. It is a method based on turn-taking by [9], activity theory by [10] and integrated with see-saw modeling [1]. Utterances (i.e., could be composed of many) are categorized into topic categorizations. This is shown in Table 1.

Next, we have identified 6 topic categorizations. We show the topic categorization. The dialogues (example shown in Section 2) have been segmented into groups of sentences that are about a particular topic. For example, who is the actor (i.e., coordinator or executive) that introduces a topic (e.g., EleGI=>BSpace) at time_n and followed by which actor replies to this topic and with what as the topic reply. Each topic may include several utterances. This is shown in Table 2.

Topic	Significance
Bspace [4] =>EleGI (abbreviated as: B=>E)	Using/identifying BuddySpace features for any directly related EleGI work task or discussing about BuddySpace itself to use for EleGI deliverable.
EleGI=>Bspace (abbreviated as: E=>B)	The speaker has primary the motives/intention to speak or discuss directly related EleGI subjects.

[3] Please refer to [2] for the details.

[4] Bspace is an abbreviation for BuddySpace.

Topic	Significance
Bspace=>Activity (abbreviated as: B=>A)	Using BuddySpace to do a precise activity (e.g., inquiring if the user is there; debugging BuddySpace tool) other than deliverable discussions.
Activity=>Bspace (abbreviated as: A=>B)	Other activities that is not directly related to EleGI (e.g., pause or exit) that uses BuddySpace as a medium to inform one another of the state of their current, previous or future activities.
Procedural (abbreviated as: P)	Both are engaged in a shared activity. For example both may be looking at the same document and discussing about the contents of the documents or debugging a tool together.
Misc (abbreviated as: M	Change of topic that is unknown yet for the other user, such as "by the way, one quick question". Also concerning social aspects such as greetings.

Table 1: Topic categorizations.

Statements	Actor	Operation
[2004/04/19 10:01] <Executive> are there **any notes** from **that meeting**?	E	EleGI=>Bspace
[2004/04/19 10:01] <Executive> (or anything **I need to see**, in other words)	E	EleGI=>Bspace
[2004/04/19 10:01] <Coordinator> **there will be updated ".ppt"** one for each SEES very soon	C	EleGI=>Bspace
[2004/04/19 10:01] <Executive> cool	E	EleGI=>Bspace

Table 2: Statements, Actors, and Operation.

Refer to Table 2. The statements in bold determines the topic to which this statement belongs to. In order to validate whenever the number of topics has relationship to pause situation- Cramer's V Chi-Square test conducted.

	Value	Approx. Sig
Cramer's V	.854	0.015
Contingency Coefficient	.770	0.015

Table 3: Symmetric Measures.

Refer to Table 3. Contingency is used to record and analyze the relationship between two or more variables. The low values of contingency coefficient indicate that there is a relationship between the two variables. The closer V is to 0, the smaller the association between the nominal variables. On the other hand, V being close to 1 is an indication of a strong association between variables. Cramer's V value 0.854 indicates that there is a strong association between the pause frequency counts to the number of topics. The low significance value for both Cramer's V and Contingency Coefficient, 0.015 indicates that *there is a strong relationship between pause frequency counts to number of topics*. In other words, whenever there are different topics (i.e., activities) taking place simultaneously, the system is more vulnerable to breakdown situations. The topic segmentation is later entered into a table and statistical analysis was performed on it to validate if the data were significant.

From	To	B=>E	E=>B	B=>A	A=>B	P	M

From	To	B=>E	E=>B	B=>A	A=>B	P	M
B=>E		EC 3EE	EC EC		CE		
E=>B		3EE	EC EE EE CE CE		EC EE	EE	
B=>A							CE
A=>B		EC	EE CE		EC EC EC EC 3EE CE 2CE 2CE	5EE	EC
P			EE		EC EE EE	EE 2CE 2CE 4CE CC 2EE CC 2EC 4EC	
M		EC		CE			

Table 4: Topics transitions of turn taking scheme for speakers for 19.04.04

Refer to Table 4[5]. For each pair, we want to identify if one appears much more frequently than the other pair. In order for a pair to be dominant, following [2], a partner must be missing. Also, a transition is to be dominant is that the ratio must be at least 3 to 1. If readers refer to Bspace=>EleGI To Bspace=>EleGI, notice that 3EE has the ratio of 3 to EC. Another dominant turn taking is EleGI=>Bspace To Bspace=>EleGI because the partner (EC) is missing. There are some reasons why we would like to identify the more dominant speaker in topic transitions, some of them are (i) this topic/operation is more concerning E/C; (ii) this subject is more of E/C's focus than the other; or (iii) E/C has more knowledge in this topic. Some of these characteristics in relationship between the group member's role and their concerns could imply for us to understand in what way was the tool useful for them. We recognize patterns emerging from different topic-transitions. For example, for topic transitions Procedural to itself, certain information can be discovered in identifying the turn taking dominancy by referring to E/C's communicative acts [1]: (i) Confirm, and then inform-ref is more dominantly communicated by C.(ii) Request, and then inform-ref is more dominantly communicated by E.

It was observable that in different operations, the order of the communicative acts varies depending on the role of the

5 Table 4 does not contain values for all cells, which is why we use Cramer's V to examine the association between nominal variables. Cramer's V is also used for tables that is more than a 2*2 contingency (normally used for larger r*c table). Cramer's V represents the association or correlation between two variables. V defines a perfect relationship as one, which is predictive or ordered monotonic, and defines a null relationship as statistical independence.

actors in different context of communications. In turn this influence how the actors use the functions of BuddySpace and also in *what order in which context* is the BuddySpace *function used* for carrying out *which operation*. For example, C is "conforming" to his role as a coordinator, mostly confirming, validating or clarifying information. On the other hand E is "conforming" to his role as an "executive". Coordinator acts as an "EU" mediator who makes sure that group members follow the guidelines provided by "EU". The Executive has to manage the goals of the institution together with the overall goal of the scientific council. Therefore, E during Procedural transitions would commonly ask for validation on specifications by EU that helps him to manage his own institutional plans. Cramer's V test was similarly conducted on Table 5.

Table	Value	Approx. Sig
2	0.754	0.00

Table 5: Statistical analysis of table.

Refer to Table 5. It has the association value of 0.754, whereas the low significance value, 0.00 indicates that there is a relationship between the two variables. In simpler words, there is a strong relationship between topic transitions to roles in turn taking sequences.

EVALUATIONS

In this paper, we introduced a general method that was originally formulated by [2]. It was used in our work to analyze multi tasking activities and to understand the nature of work practice of scientists collaborating on the Web via the IM. This method is general enough for analyzing communications on the Web by focusing on topics, turn-taking, roles and functionality of the tools. When the chat contents (i.e., sentences) are segmented into topics, the topics are hypothesized as having relationship to; (i) who dominantly introduced a topic; (ii) who 'submissively' follow the introduced topic. It is a method based on the hierarchy of activity theory; motives-action-operation. Based on this method, we evaluate the first hypothesis- *changing tools to get some task done, makes the system vulnerable* is true. For example, a user may be attempting to add a new user to the BuddyList at the same time receives an invitation for attending a group conference on the BuddySpace may cause the BuddySpace to "freeze". Another common problem was that during chat, a user that is likely to be triggered by ongoing conversation with previously discussed topic attempts to load chat history. If the chat history takes a long time, system is likely to freeze. Therefore, the loading of a whole chat history can delay retrieval process and possibility of system vulnerability.

From the statistical analysis that whenever there are more topics discussed, the pause frequency was higher, and also breakdown situation was likely to follow. The preliminary finding is encouraging. With the small but significant understanding of how 2 people collaborate online, it allows us to highlight some weaknesses in the current tool. Further work will be applying the topic categorization method on the rest of the chat logs. In particular, this method will be adapted to analyzing more than 2 collaborators. One of the foreseen contributions with future findings is to assist Buddyspace tool designers to understand better how users use the current tool functions.

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Design Patterns in Ubiquitous User Interface Design

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ABSTRACT
Ubiquitous computing as a design and research area is evolving rapidly but is currently characterised by a lack of design principles as well as a solid theoretical foundation. As a tentative first step in establishing this, I propose the concept of design patterns and pattern languages as a very promising means for capturing and sharing design experiences within ubiquitous user interface design. I will identify key concepts in design patterns that relate to HCI and ubiquitous interaction and discuss the challenges in creating a pattern language for Ubiquitous User Interface Design (UUID).

INTRODUCTION
The development in pervasive and ubiquitous technology places researchers and designers with the challenge of understanding human-computer interaction as happening in multiple, more or less ad hoc, and even changing configurations of instruments. In this context, *ubiquitous interaction* can be defined as having more than a single focus for interaction, being intrinsically mobile, and dealing with a changing configurations of artefacts - both physical and computational. Thus, the interaction becomes more complex and yet we have little to guide us when designing ubiquitous interaction and user interfaces. This paper describes the first steps in developing design guidelines for ubiquitous interaction as part of the UUID project[1] which has the overall aim to engage in the development of the theoretical foundations, new methods and design guidelines for the field. One step in this direction is to assess, and hopefully utilise, design patterns and pattern languages with departure in the original pattern language by Alexander [1] as a means for capturing and sharing design experiences within ubiquitous user interface design.

In the following, I will look at some of the key features that describe design patterns and a pattern language and point out how they may help us address central issues within HCI and ubiquitous user interface design.

KEY ELEMENTS OF DESIGN PATTERNS
The first well-established and utilized pattern language for architecture was developed by Christopher Alexander and colleagues at the University of California, Berkeley. The overall purpose of the pattern language presented in [1] was to provide architects and users with a shared tool in design: "*The emphasis here was on an entire language for design, since the usefulness of patterns was not only in providing solutions to common problems, but also in seeing how they intertwined and affected one another.*"([5],p. 234)

Why design patterns are particularly suitable for the purpose of ubiquitous interaction will be described through the identification of key elements of the original design pattern idea that relate, methodologically, to the way we have and still do work cooperatively, iteratively and cross disciplinarily with interface design and HCI in general.

Design patterns are dynamic: "*You see then that the patterns are very much alive and evolving. In fact, if you like, each pattern may be looked upon as a hypothesis like one of the hypotheses of science. In this sense, each pattern represents our current best guess as to what arrangement of the physical environment will work to solve the problem presented.*" ([1], p. xv)

This corresponds well with the focus on an iterative design process within the HCI community and the understanding that design of technology is an evolving process that can only be fully understood and evaluated in use (e.g. [4])

Design patterns are always part of a larger whole: "*In short, no pattern is an isolated entity. Each pattern can exist in the world, only to the extent that is supported by other patterns: the larger patterns in which it is embedded, the patterns of the same size that surrounds it, and the smaller patterns which are embedded in it.*" ([1], p. xiii)

This corresponds well with the classic understanding of cooperative design which states that design of artifacts is more than designing the physical "thing"; we also design conditions for human use (e.g. [7,11]). Furthermore, [2,19], both discus that new technology cannot be developed without considering the already existing systems in use, as well as the use practice in which it is to be introduced.

Patterns and pattern languages are based on design experience and supports interdisciplinary collaboration: "*It is a language that we have distilled from our own building and planning efforts over the last eight years. You can*

[1] See www.daimi.au.dk/uuid

use it to work with your neighbors, to improve your town and neighborhood." ([1], p. x)

Thus, the design patterns are conceived as a tool, not only for architects, but for all stakeholders in a design project, enabling them to communicate and work together around a given project.

This corresponds well to the classic cooperative design approach presented in e.g. [11], which understands design as a cooperative, iterative process which crosses boundaries between work practices and which must involve active participation from relevant stakeholders to be truly successful. This approach is still prevalent in HCI research today, exemplified in the work of e.g. [14], dealing with design of technology for and with children, [19], dealing with mobile work and the design of mobile technology to support it, and [20], dealing with design of technology for the home.

A BRIEF HISTORY OF DESIGN PATTERNS

I will now trace the development of design patterns from their roots in architecture over software design to HCI and comment on the challenges we face when moving into the area of ubiquitous computing.

Design patterns in software design

With the publication of the book "Design Patterns: Elements of reusable object orientated software." by Gamma, Helm, Johnson and Vlissides [9] – popularly knows as the "Gang of Four" or simply GoF - design patterns was introduced to the field of object oriented software design with great success as a means for capturing and sharing good design solutions. It is easy to see how the hierarchical structure of a pattern language and the relationships between design patterns have appealed to software engineers working with object oriented programming. However, the grand structuring scheme of a design language never quite caught on within this community; rather, most collections of design patterns for software design are exactly that: weakly connected collections or "catalogues" of good design solutions rather than a well-connected pattern language [6].

However, the contribution of design patterns in software development is inarguable and highly visible. The use of design patterns in software design has given software developers a shared "language" of solutions or collection of good design stories through which they can share their experiences with software development. The key point is then not necessarily the economics of the reuse of design experiences, but the shared understanding of software design as a field that the software design patterns help create and the recognisability they afford. Thus, design patterns in software design are valuable because they help strengthen the design *community* as much as they support capture of effective and efficient design solutions.

Design patterns in HCI

Conceptually, the idea of design patterns and pattern languages corresponds extremely well with the challenges we face within HCI and ubiquitous computing; the focus on design as a process that evolves over time and is based on interdisciplinary collaboration; the focus on seeing design as a process that shapes not only the thing we are designing but changes the (social) context of which it is part; and the focus on creating a tool that will aid us in the process by being able to capture and share design experiences and thus create a common language for collaboration around a given topic are all central to the cooperative design approach that has existed since the late 70'es. However, as described in [22], design patterns have, unfortunately, not fulfilled this potential in HCI in the same manner in which they have been embraced within the software design community.

When Jennifer Tidwell published a collection of UI patterns in 1997, this was the first serious attempt to use design patterns for capturing design experiences for the area of HCI. In [21], the users of the patterns are described as: "*...people who design user interfaces, Web sites, books, control panels, and other such things*" ([21], p. 3). With this, she clearly emphasizes the role of design patterns as shared, cross-disciplinary tools for design. Her efforts pinpoint two of the most valuable aspects of design patterns that are continuously emphasized by the HCI research community are their ability to function as a *tool for communication* in the design process and thus *support a collaborative design effort*. [8] presents design patterns as a means for creating a common language – a lingua franca – that can be used by all the stake-holders in a design process and is not owned by the designers. [6] introduces design patterns as an aid for *user participation* in the design process and, like [8] argues that design patterns yield a high potential for creating a shared language between the different participants in participatory design processes. I find the concept of patterns as communicative tools extremely compelling in relation to ubiquitous user interface design and agree with [6] when they re-emphasise the original focus for design patterns as sharing design knowledge not only in the design community but also with other potential stake-holders in the design process, particularly the users.

The use of design patterns in cooperative design has also emerged recently. [18] takes up the challenge of describing design patterns in CSCW design – patterns of cooperative interaction. This paper introduces the use of patterns in ethnographic studies as a means for bridging the gap between field study observations and concrete implications for designs and describes how they identify and generate patterns from their ethnographic material. Finding concrete ways to connect field study observations and concrete design is highly relevant for the HCI field in general and CSCW in particular. The evaluation of collaborative systems and the use of design patterns for this purpose is also the topic of [13]. Guy proposes a pattern language based on the framework of activity theory to capture key findings from a field study and modelling them into patterns of activity. She argues that the unit of analysis and the concept of hierarchical levels of activity provide ways of defining relationships between patterns, and I find the comparison between design patterns and activity theory both compelling and interesting, particularly as it has been described in [12].

The greatest problem for design patterns in HCI is, however, the question of the *structure of pattern languages* for HCI. In general, the use of design patterns in HCI and user interface design suffers from lacking a solid foundation or design principle by which to guide the structure and organization of the individual patterns. [10] presents a pattern-supported approach to user interface design that tries to pinpoint some of the important features in HCI design that could be captured by patterns. However, the relationship between the different "types" of patterns proposed is not clear because they lack a clear design philosophy. This is also the case with [17] who look at pattern languages for usability in general. They present patterns of tasks, users, user-interface elements and entire systems as four different kinds of patterns in HCI but do not reflect on the specific categories nor on their relationship to each other. However, the authors do emphasise that "*a pattern language should be based on a coherent underlying philosophy*". [21] is yet another example that shows a collection of patterns and tries to tie them together but fails to present a clear design philosophy to aid the organization of them. [23] very clearly proves, by looking at the examples given at the different levels in the proposed hierarchy (namely posture, experience, task and action), that this area suffers from a general lack of conceptual structuring for patterns. We see very few high-order patterns because it is easier to generate patterns and insert them into a structure than construct a design philosophy for the patterns to form the basis for the pattern language. However, [23] takes this challenge of how to structure design patterns into a relevant, meaningful pattern language for a given area, in their case, interaction design, seriously. They argue that it is neither possible nor meaningful to try to structure patterns into a language before concrete patterns exist. I only agree partly and will instead argue that creating design patterns and a pattern language for Ubiquitous User Interface Design requires a combination of a bottom-up approach where we draw on our concrete design experiences (as well as that of others in our local research community – as argued by [18]) for creating the specific patterns and a top-down approach that provides an overall conceptual structure or design philosophy. Concrete patterns do not magically fall into a hierarchical structure when they reach a critical mass. Rather, building a pattern language requires a clear understanding of what you are aiming for to structure and develop patterns for a specific context and language as much as a number of concrete patterns available at any given point in time. However, it is undoubtedly easier to work bottom-up than top-down when developing a pattern language, which is also the experience in [5], but I will argue that if we do not keep the overall structuring principle in mind, our organization of the patterns will become more fragmented and random. Thus, I will argue that it is necessary to have concrete design experiences/patterns to build the pattern language but the presence of an underlying principle or philosophy for organizing them is equally important, particularly for providing structure and understanding the relationships between patterns, but also as an aid in identifying more patterns. The organizing principle will guide us in this by asking questions about how to solve a given problem and thus help us formulate relevant patterns for this, helping us to progress downwards in the hierarchy.

I find the work by [23] highly relevant because it puts focus on different possible types of relationships between groups of patterns or the levels in the hierarchy. We need to analyse the pattern structure thoroughly to identify which relationships we see between patterns, levels of patterns and groups of patterns in order to sustain the design philosophy of ubiquitous interaction. However, I find the starting point of structuring the design patterns for interaction design as a hierarchy of problems interesting and will look further into that as we progress with our work within the UUID project.

DESIGNING A UUID PATTERN LANGUAGE

Design patterns for ubiquitous computing are gradually gaining attention, particularly with respect to the prospect of having a tool that allows for more rapid dissemination of "*new interaction techniques and evaluation results by presenting it in a form more usable to designers*" ([5], p. 233). Design patterns can be used to document lessons already learned in the field of ubiquitous computing and thus help inform the design of ubiquitous technology [16]. However, common to the efforts described in [5,16] is the lack of a design principle to support the formation of a pattern language. Despite their argument that the field is not mature enough – i.e. lacking a sufficient number of ubiquitous patterns – they acknowledge the importance of making a structured effort in capturing design experiences. I see this as excellent starting point for showing the strength of a combined top-down and bottom-up approach in generating and structuring a coherent pattern language for ubiquitous user interface design.

Key questions to be answered with regards to creating design patterns and a pattern language for UUID include:

1. What is the theoretical foundation for the UUID pattern language we propose? Promising candidates include activity theory and embodied interaction.
2. What is the underlying philosophy by which we structure the patterns into a UUID pattern language?
3. What describes the overall ordering principle? Spatial and temporal expansion? Deconstruction of problems - scale? The design process itself?
4. What is a relevant granularity and scope of the pattern language?
5. How do we perceive the relationship between levels and groups of patterns in the pattern language (e.g. specialization, instance-of, related to, etc.)?

6. How can we begin to describe “the quality without a name” in ubiquitous user interface design and does the concept make sense in this setting?

I will address these issues in my continued work within the UUID project and, where possible, base the emerging pattern language and design patterns on our other efforts within the project. Some of the most promising results are [3], that describes an activity-theoretically based framework for analyzing *ubiquitous substitution*, e.g. using different tools for similar tasks interchangeably, and [15], which challenges the predominant monolithic application concept and argues for deconstructing complex interaction tools and systems into detached interactional instruments.

SUMMARY

Design patterns show promising prospects for providing concrete design “guidelines” for ubiquitous user interface design and make them available to practitioners. I will look further into developing a pattern language for ubiquitous user interface design within which we may record our and our colleagues’ good design experiences as design patterns.

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Designing for multi-mediation

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ABSTRACT

This paper discusses how HCI is most often focusing on one mediator/interaction design at the time, at the same time as human activity in general is most often multi-mediated. The lack of focus on multiple interaction is particularly problematic in a situation where HCI becomes increasingly focused on ubiquitous and pervasive interaction.

This paper discusses what we might gain from systematically designing for multi-mediation and how this may be approached. The paper will base itself in activity theoretical HCI.

INTRODUCTION

Much of HCI has been focusing on one technology-one application-one user, be this when designing interaction, analyzing use, or when providing theoretical frameworks for either of those. However, the recent trends of pervasive or ubiquitous computing place the user in dynamic configurations of technology, where human activity is not necessarily performed through a single personal computer application but supported by a range of technologies and physical artifacts that are even dynamically changing through mobility. This kind of multiplicity is well-known from everyday artifacts in general: When a pilot is maneuvering an aircraft, the captain a cargo ship, or the mason is building a house, there is not necessarily one single unified interface between the user and whatever is the object of the activity, be this the safe journey of the aircraft, the optimal route of the cargo ship, or the brick walls of the house. Instead, one will see one-to-many or many-to-many relationships between the (collaborating) users, the instruments they are applying and the objects of their activity at various levels.

THEORETICAL FOUNDATION

In the UUID project, we propose to understand ubiquitous interaction as changing configurations of instruments that mediate human action on various objects that are present in or through the mediators. In our quest to provide a theoretical basis for such an understanding, we have focused on activity theory.

While this framework in various ways points towards multi-mediation and has been used for analyzing multi-mediation in various real-world activities, it has not yet been used prescriptively in interaction design of ubiquitous interaction.

MULTIMEDIATION

Multiple and distributed interaction is tied together by and through the user. The users' image and understanding of the activity is created from the ongoing interaction with the configuration of artifacts, and not from a singular unified interaction. In order to understand a use situation and the roles of the technological mediators in use, I will summarize some recent findings from my own work. I propose that by understanding how multi-mediation happens in mundane everyday situations we may better be able to design for the multiple interaction of pervasive and ubiquitous technologies.

In [3] Olav Bertelsen and I conclude that activity theory allows us to change scale and study connections on multiple levels of activities where computer-based mediators are used and designed, without establishing a permanent hierarchy in the analysis. We focus on multi-mediation when mediators as part of more than one use situation, use situations and contexts are non-hierarchical, many actors focus on the same object, and there are several mediators the same activity.

Through our analyses we illustrate how such multiple mediation unfolds in a wastewater plant where the mediators are a combination of very big artifacts e.g. the plant as such, and rather small and specific ones such as a bucket on a stick: The basic mediation in the waste water plant is simply that the plant mediates the process of turning waste water into clean water. As analyzed in [1] it is the plant manager, together with a small group of workers, who are the acting subjects as regards the overview and optimization of the wastewater process. Nonetheless, many of the steps in the mediation process are carried out by other actors, and it is only through the entire chain that controlling the plant is possible.

In one of our examples, Joe who works in the plant samples water samples, processes them in the lab, enters the results into a protocol sheet, and carries the numbers to a different room where they are entered into the control system (Fig. 1).

In this process, the plant as such is transformed into figures on paper in a process where meters are read. The meters mediate the production of numbers on a piece of paper. The paper is carried around and ends in a room, where the accumulated numbers are entered into a paper protocol publicly inspectable on a desk. The paper protocol contains accumulated figures for all days of the month. The paper mediates the production of the protocol. The protocol in its turn makes possible (mediates) the inspection of the state of the plant, and it mediates the structuring of numbers to be entered into the computer system. Based on these numbers, the computer system mediates the regulation of the water purification process.

The wastewater plant mediates the purification of polluted water into clean water. This mediation has many other kinds of mediations embedded in it: reading off sensors are means for the workers as well as for the control system to record the state of the plant. A sludge press is applied to regain as much water as possible and to reduce the amount of sludge to be removed from the plant. A water container is used to carry water from the wastewater basin to the laboratory.

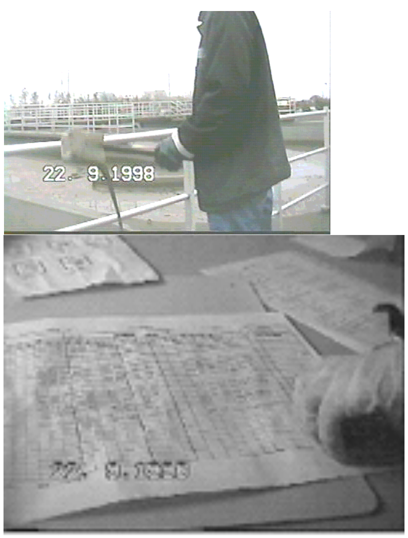

Figure 1. Multiple mediators: Sampling sludge and entering numbers in the protocol.

Similarly, multiple mediators come into play in our recent map study [4], even though only one computer artifact is applied at a time, namely as an electronic map on a tablet PC. When the pairs we followed were identifying a target, they went through iterations of looking at the map, looking out, and trying to remember from past experience until they identify the target.

The maps and views do not stand alone as mediators. All of the groups uses anecdotes and stories to talk about, and reminded each other of where a particular place is, what it is called, etc. (Figure 2).

Having recognized that, in the large and in the small, human activity is multi-mediated, we move on to look specifically at what happens when the same artifact mediates several different purposes, and what this might mean for interaction design.

A: It's on the other side of Brendstrupsvej	A looks out. B looks at the map
	They both look at the map
B: It is Møllevangs Alle	
A: No, Katrinebjergvej	The both look out
B:… difficult to see	
A: It is difficult to see	
B: There must be a… See, if Åbogade goes up there. Then there is at least one block be-tween.	B points at the map
B: It must be here, it may actu-ally be all the way over there	
B: it is difficult to see how many blocks.	A looks out, A points out
	B points at the map

Figure 2. Transcript from map study showing how the view out the window is an additional mediator to the map.

Multiple interaction

In the wastewater case, we encountered the following situations [2, 3] when Bob is reading the gas meters:

Situation 1: Bob handles a large number of dials and meters (see figure 3) every time he does the reading to calculate the amount of produced electricity. Some of the meters are just counters/numbers where others have a needle pointing at a scale or are light-bulb-buttons. Some values are read instantly while others need to be focused on for several seconds before the values are written down and used for calculation of electricity.

Situation 2: The dial is read in order to undertake trouble-shooting regarding a gas turbine (figure 4). Bob inspects the gas turbine and gets a feeling that something is wrong with it. He walks to the board with dials and meters, and identifies the meter relevant to the particular turbine. He focuses on the possible movement of the hand so as to see if there is any change in the running of the turbine.

Figure 3. Reading dials for the protocol

Figure 4. Reading dials for trouble-shooting

This example is an indication that really the detailed interaction cannot be understood without apprehending the purpose of the human activity – while the reading of the hand in the first situation could be done with much greater precision in the first situation, e.g. by showing the user a set of digits, this would not necessarily support the second situation without causing severe problems with constantly flickering numbers.

Levels of purposes and mediators

In a way similar to running a wastewater plant, a large cargo wessel [6] is maneuvered by the captain of the ship. As pointed our in the work of Peter Bøgh Andersen, this is at times done by the captain alone with the help of an autopilot, and at other times together with others, including a local pilot.

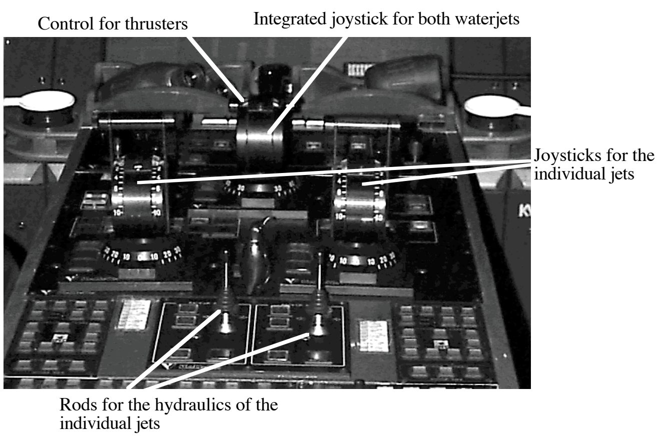

Figure 5. Multiple mediators on the bridge of a fast ferry (figure by Peter Bøgh Andersen)

Some ships use water jets for propulsion and can have from two to four of them. The individual jet can be positioned to point in different directions, and its power can be regulated. In idle state the jets point towards each other and cancel each other out. Full speed ahead is achieved by turning all jets in the same direction. A joystick is used to control these: it has three degrees of freedom and can be deflected in all horizontal directions (bow/stern, port/starboard) and contains a part that can be rotated. Figure 5 shows an arrangement from a fast ferry. Although the captain can manipulate the speed and course of the ship directly, he is still control the jets individually, and even exert direct control over their hydraulics. In [6] we discuss how the crew seems to mover rather smoothly between these levels of interaction, and awareness. We identify 5 levels that the pilot (P) and the captain (C) seem to move between (Figure 6).

This example illustrates how the human user manages the connection between the mediators at the various levels, and is able to switch back and forth between purposes, levels, and hence, mediators. We will look more into the work that these changes takes in the following.

1. Spatio-temporal norms related to vessel position and heading.	P (leaving a harbour): he is coming *without a pilot*. Yeah, he is gonna pick up a Pilot ... in here, to go to Ipswich, which is sometimes a bit of a *problem* cause they don't always… realise exactly where they *should be in the channel*
2. Vessel movements	P (about speed): So we need about seven *knots* C: Yeah so we better start coming down…Yeah C. Yeah we will kill some *speed* when ... while *turning* here .... P: …*turning* yes
3. Vessel momentum balance	C (about the diminished effect of the rudder due to low speed): Now look, you have to take care, now we *reduce speed*, right, so the wind *gets more power* over the ship, and...and starts so...there is possibly *some current* too, so give it five degrees drift to port.
4. Force production	P (worried about the functioning of the thruster): is she always *working*? C: The thruster? P: The thrusters, yeah. C: Yeah.
5. Appearance and location of control devices.	C (about the size of the thruster propeller): what is the *propeller diameter*, it is something like, it is around *a meter*, not more, or *a meter and twenty*, I can't remember .

Figure 6. Levels of operation and mediation on the ship bridge.

Configuration work

In [8] Martin Nielsen and I analyze the use of several mediators and the physical space in which these are placed in relation to a taxation control process.

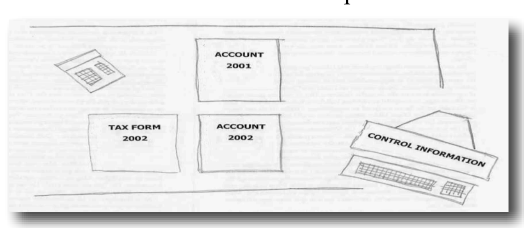

Figure 7. The taxation desktop

The case officer checks the control information to see if the system has discovered any inconsistencies between the information reported by the taxpayer and those registered as control information. At this point the system has localized a difference in the reported and the registered interest expenditure amounting to 37.165 DKK.

Next, the case officer examines how this difference was established. He consults the relevant pieces of interest information in the system and recalculates the difference between the registered and the reported figures: "Then we take 95.870, there, and up here 21.259 and 45.563 were registered, in total 162.692 [Total interest expenditure reported by tax payer]. And the system only knows about 32.655 and 92.872 [Interest expenditure registered in the system]. This means that there is a difference of 37.165."

The established difference serves as a definition of the problem the case officer needs to solve. He searches trough the balance sheets to see if they explain the difference. Soon the case officer localizes a "loss due to depreciation" amounting to 37.313: "Here we got the explanation of the difference. It is very close to what we have got here [pointing at the display on the calculator]."

The difference of 37.165 is propagated across a number of mediators (control information, calculator, and balance sheet). By aligning these, an inconsistency is dismantled. The inconsistency is resolved by localising "a loss due to depreciation" not registered in the system. Here the officer's knowledge of the body of tax laws enters the equation. In the words of one of the workers: "The system is stupid. (…) It just says that there is a difference from its perspective. We have to be able to tell if it is a genuine difference or not." [8].

Just like coordination between people requires articulation work, and mobility of devices requires mobility work, the switching back and forth between mediators requires *configuration work*. In [8] we discuss how a tax officer is making use of physical space, aligns artifacts, etc. simply to be able to carry out his task of auditing a tax form. The taxation case further illustrate one important element of multiple interaction, namely the work that the human user does to make multiple objects and mediators work together. [5] introduces the concept of *webs-of-technology* in an effort to embrace the understanding that we never design single, monolithic devices or systems but technology that must be seen and used in relation to many other devices, applications and systems. Webs-of-technology are used to describe ubiquitous interaction as a process of negotiation between the users and the technology, focussing on the availability of technology and interpretability of services. The taxation case is a very detailed example of how this happens, even in routine situations. [8] discusses how the desktop is used to structure the process and align the mediators, and how this would not be possible on the classical PC desktop.

SUMMING UP

I hope to have established that by looking at one mediator at the time one misses the configuration work, whether this takes place by the human user walking up to the mediators (Zooming with the feet, as in the case of the wastewater plant), or it is about aligning, substituting, juxtaposing and chaining mediators.

In contrast to everyday artifacts, the only configuration work possible on a PC is time ordering, which means that we need to look at different interaction paradigms in order to design for ubiquitous interaction.

In the final presentation I will discuss further what kinds of consequences the multi-mediation perspective has on ubiquitous interaction. In particular I will discuss recognizability, as an alternative to consistency.

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Activity-Based Design as a way to bridge artifacts, professions, and theories

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ABSTRACT

This paper will focus on the challenges in designing pervasive computing technology for children's play, taking into account current trends in popular culture. In search of theoretical support for this work I have been exploring an activity-based approach called 'habitats' to describe the conditions around various design projects, and it seems to have some value. I will present my experiences from a playful pervasive gaming system for children and the problems I faced trying to find a solid theoretical paradigm. The paper argues that habitats with its three perspectives – physical, informational, and pragmatic – together with the ability to describe their relations are a useful platform for practitioners and theorists who are forced to span a heterogeneous mash-up of technologies, theories, and professions.

Keywords

Pervasive computing, design methods, multidisciplinary design, activity theory, habitats

INTRODUCTION

With the still earlier adoption of mobile phones, instant messaging and various digital entertainment systems, pre-teen and early teenage children – tweens[1] – are becoming heavy users of mobile computing technology and digital services [4], at least in 'Westernized' societies. In 2000, the age at which half of all Norwegian children in their year group had a mobile phone was around 13, in 2004 it was between 9 and 10 [9]. A recent Japanese report [8] projects that the percentage of 5- to 9-year-olds owning a mobile phone will go up from 29% in 2004 to 64% in 2007. In other words, it is not so much a question of whether or not children should be using these new media, but rather how they will be using them and what for.

This development calls for a clear focus on design of mobile, heterogeneous systems for children. When there is a market, businesses will fill out this market with products and services. But how do we approach this development from a research perspective?

Like in other areas of pervasive and distributed computing, it is not clear how classical one-to-one HCI or groupware experiences transfer to the new situation where loosely coupled systems and tools are the users' reality.

Maybe the situation has not changed fundamentally in all aspects. After all, human activity has always de facto involved a heterogeneous 'environment' of a more or less dependable nature. But some things have really changed the way (some) technology is used and perceived.

Having a global information network potentially present in every corner of the environment *is* different.

The question is how much of the old wisdom still works and where we have to adopt new views and methods when designing and analyzing use of interactive systems.

USEFUL THEORIES

As mentioned, children are a special case of this situation. Even if we wanted to, we cannot shield them from mobile and networked technology. Numbers and experience show that.

There is a whole spectrum of relevant theories, from the computer science-based fields of Human-Computer Interaction (HCI), Computer-Supported Cooperative Work (CSCW) (and Computer-Supported Cooperative Play (CSCP)) over Seymour Papert's Constructionism (e.g. [10]) to sociology, ethnography and theories of play and games.

In the following I will highlight one of them which focuses on reconfigurability (in a very broad, cultural sense) and add a link to the activity-based approach, based on the notion of 'habitats', afterwards.

The impact of technology on children's popular culture

In her analysis of the production and consumption of children's software, Mizuko Ito [7] draws attention to the interplay between new media, child culture and entertainment industries. She draws a parallel to earlier trajectories of the impact of other media, e.g. movies and television, toward a "junk culture", but she characterizes the junk culture as "a particular vernacular that that cross-cuts media and commodity types". By calling it a vernacular – a particular form of expression used within a particular group of people – she suggests that children's popular culture should not be demonized as something entirely bad and detached from "authentic kids' culture",

[1] In the literature on popular child culture, the term "tween" is usually referring to girlhood and girls between 7 and 12 years of age but it may as well include boys.

because it is used by the children to serve quite natural functions in their lives and development.

> Although the founders of the children's software industry were looking for a radical break from the existing logics of both entertainment and education, when children's software entered the political and economic mainstream, industrials began reproducing familiar vernaculars that played to mainstream retailing. Kids mobilized these new cultural resources in ways that fit their local peer agendas and intergenerational negotiations. ([7], p. 101)

This view resembles the attitude found in Seymour Papert's constructionism [10] which encourages educators to set loose the power of the mind to learn and to create with the materials at hand, not just to receive instructions. But Ito extends her view to include popular culture in combination with new media and invites us to look at what is actually going on. One place to start is to look at the children's activities in the context(s) they take place.

> The atomized consciousness of a player engaging with a special effect is a small moment attached to a large sociotechnical apparatus. [...] Multimedia and interactive media are not inherently "fun" or "educational" but take on these characteristics through a highly distributed social, technical, and cultural apparatus. [...] As alternative models for software production and distribution take hold, we may find that the Net is trafficking in forms of children's software that may truly redefine some of the cultural logics of contemporary childhood that were established in the television era. Whatever change happens, it will not be an effect of factors inherent in a particular technology but of a whole complex of discursive, social, political, and economic alignments that link sites of production, distribution, marketing, and consumption. ([7], p. 100f)

She also indicates that the "widespread game hacking and remix" that have followed with new technologies such as broadband internet may turn out to play an important role in changing some of the childhood cultural logics. Others agree. Scarlett et al. [11] add that it may be difficult to evaluate what is going on, "when we are in the middle of a revolution" (p. 112).

Habitats

Heterogeneity is a fundamental circumstance in all efforts concerning the analysis, design, development, and use of ubiquitous computing technology. Drawing on other traditions, several attempts have been put forward to help theorists and practitioners in understanding the tools, materials, and possibilities, and operationalizing theoretical analyses to practice. But putting together comprehensive theories, one of the biggest hurdles becomes putting it into practice.

One approach, which I have explored, is *Habitats*, which is based on the notion of a biological habitat. Similarly to activity theory [2] it has human activity as the basic unit. I have applied the approach especially to pervasive gaming [1] and to intensive healthcare [5].

Habitats claim to offer a view on an activity which is sensitive both to the situation as a whole and to particular aspects that are important to address specifically.

Habitats consists of a set of concepts and diagramming techniques for designing and modeling environments for nomadic, collaborative activities that include elements of pervasive computing, i.e. mobile and embedded digital media.

We are interested in physical spaces that are designed or have evolved to support a delimited set of human activities. This is true for an overwhelming number of the spaces we live in daily: private houses, airports, hospitals, railroad stations, road networks, etc. We have chosen the term habitat to denote a physical space that is designed to support some set of activities and which provides access to information about objects relevant to the activities:

- A *habitat* is a chunk of space-time that is designed or has evolved to support a delimited set of activities by offering physical artifacts and information sources useful for conducting the activities.

From this definition, it follows that a habitat should be characterized along three dimensions:

- The *physical* dimension: the physical layout and boundaries of the habitat plus the available physical artifacts.
- The *informational* dimension: the signs available (access and reference area) to participants in the activities (digital and non-digital signs).
- The *pragmatic* dimension: the action affordances offered by the habitat, the macro-roles and the role-requirements of the participants.

Habitats are structured around activities. We adopt a functional view of activities [3, 5].

The framework consists of roles, participants, actions and activities. Activities consist of actions subsumed under a shared goal, and participants play roles in relation to actions and activities.

Operationalizing comprehensive theories with habitats

To illustrate how habitats can be used to actually address some of the issues raised by Ito [7], I will outline a few examples for further discussion.

To do so I first introduce the example case: DARE! Then we will look at the activities of the different roles in the light of the three perspectives on habitats: physical, informational, and pragmatic.

DARE!

DARE! [6] is a pretty simple experimental pervasive play system for tweens, i.e. pre-teen children. It lets the kids stage fun activities using their multimedia phones (with video and audio capture and playback) and other pieces of pervasive computing technology such as e.g. RFID tags (near-field ID), GPS (outdoor positioning), Bluetooth (short-range data exchange), WLAN (hi-speed, medium range network) and robots.[2] The authors have described it as a "social construction kit" [6] since it aims to support construction of social activities within small groups of peers. The activities can be more or less structured and involve more or less fiction since both the rules and the content may be changed by the children themselves. Therefore, it is not easy to categorize the activities involved as a game or "merely" play. It may be both. This particular genre has been tentatively termed "Mock Games" [6] (as in mock-up) but we shall refer to the activities as "play" and to the system as a "game" because it is easier and still somewhat accurate.

The game is designed to facilitate social engagement characterized by humor, friendly battle, and identity construction. In order to achieve this goal, the basic activity is a challenge, a dare. It could be to dare a friend to take a picture of his or her greatest love. He or she will then either do so and return the result or refuse to partake. Either response is evaluated by the sender and the result of the evaluation (a happy, indifferent or sad smiley) is sent to everyone in the group. All group members can follow all dares being exchanged within the group both on their phone, via a group website, and via RSS (a simple web feed). After a performance has been evaluated, it can be discussed on the group website. As a result, there is both a formal evaluation within the game (the smileys) and an informal one in the usual social space of the group, either on the website or face-to-face (or via whatever medium).

Physical perspective

The children are obviously in some physical surroundings. When they prepare a dare, they must be present in the target environment in order to use the surroundings for inspiration and detailed planning, and during the performance, the most important distinction is whether the performer can reach the intended places. Although the whole group can follow the status and eventually the outcome of the challenge, it makes a big difference whether they are present while it is performed. We can say that during (the sender's) design time, the physical surroundings significantly shape the dares that he or she will design. The recipient is also very dependent on the surroundings, and the kind of responses are likely to be equally influenced by the opportunities at hand.

If we compare the play scenario to work situations such as pervasive healthcare (e.g. emergency response team support), we see a similarity in the fact that it is difficult for the designers (pervasive healthcare system designers as well as Dare composers) know exactly what situation their designed activity will play out in. In fact, they can count on the unexpected to play a major role. The difference is, however, that the emergency response activity has a much clearer procedure that ties the rules and roles to physical space. The participants also know that everyone (at least the professionals) will do their best to adhere to the plan. Dares, on the other hand, involve a constant element of surprise and competition. There are dares that are "classics", but overall, even they are just a few stable elements in an ever-changing chain of exchanges.

The consequences of this on design is that the model of the game should highlight opportunities for fun and social exchange instead of adherence to protocols.

On a general level, dares may or may not be tied to designated parts of physical space, but it is always very important to know the social context, which in turn may or may not be tied to the physical space. Since the social context is the focus of pragmatic habitats, diagrams that show the relation between the physical perspective and the pragmatic perspective may help the designer to spot constellations of circumstances that invite fun, or may be difficult to handle.

Example: Receiving a dare in a classroom is very different than receiving it in the schoolyard. This will be obvious when the pragmatic perspective is related to the physical perspective.

Informational perspective

The informational aspects of the dare activities consist of the digital information in the system as well as of whatever information that may be left in the physical environment. Such non-digital or "analog" information includes physical markers of tags, bystanders informing or helping the performer, and simple signs, e.g. "Camera phones not allowed". Simply the fact the we force ourselves to consider how information that is not modeled in the system at all may play a role in the activities is important. It opens up the space for thinking creatively both at system design time and subsequently at dare design time. We may want to provide example dares that take advantage of analog information.

An analysis of the informational habitat also visualizes the relationships between where information is actually accessible (the access areas, e.g. a screen or a tag) and what it refers to (the reference area, e.g. a person or a place). By mapping these areas we get a sense of where what is available. Again this may lead to a larger, more relevant decision space at both system design time and dare design time, potentially making way for creative solutions.

In DARE!, one such situation may occur if the recipient of a challenge sees an opportunity to fulfill the requirements by enrolling proxies, e.g. a friend that is present somewhere close to an object that must be found or photographed. The system should support reconfigurations of informational

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[2] The system is implemented on a distributed architecture with the primary clients running on Nokia Symbian 60 smart phones using Flash Lite 2.1 (for the GUI) and Python (for e.g. I/O). The webserver has a standard LAMP setup and delivers a variety of output formats.

habitats by allowing the participants to change and combine access and reference areas.

DARE! will benefit from providing explicit support for altering the informational habitat in order to establish a situation that is desirable for some reason. Some practices will probably emerge as standard procedures or tricks, and over time they will be considered part of the system.

Example: A dare involves taking a picture of something far away. The recipient enrolls a friend closer by who takes the picture and sends it back so that the player can complete the dare.

Pragmatic perspective

The pragmatic habitats are characterized by the roles that are given and created. DARE! does not at the present support creation of roles, only filling or instantiation of roles by participants. One interesting feature by looking at the play scenario is that it does not necessarily matter whether a role is played by a human being or an agent, e.g. a robot or a piece of software. One can easily imagine challenges where the clever recipient can enroll non-human agents in his or her efforts to overcome it. So supporting that is added functionality compared to the current version.

Such levels of control are well-known from the transport sector, e.g. airplanes and ships that change between fully automated, semi-automatic, and manual maneuvering.

Describing and mapping the pragmatic perspective of a habitat may very well draw on thick descriptions that are distilled into simpler models of the social configurations. These may be related to the physical perspective, as mentioned earlier. But they may also be considered in connection to the informational perspective.

Example: Children (or their parents) may consider certain forms of connectivity to be worth the cost in order to bring together social situations that are otherwise separated, e.g. keeping close connection with friends after school. The potential social groups that a child may chose to become join at a given time relies heavily on the connectivity (the informational perspective).

CONCLUSION

The spread of ubiquitous computing technology in children's lives and children's popular culture present designers with challenges of a very complex problem domain.

This paper is not a proof that habitats are worth the effort of designers, but after having used habitat analyses and models in a variety of projects, as exemplified briefly above, it is my impression that these three perspectives – physical, informational, and pragmatic – together with the ability to describe their relations form a useful tool for practitioners and theorists who are forced to span a heterogeneous mash-up of technological platforms, theories, and professions.

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Ubiquitous Computing in Physico-Spatial Environments - Activity Theoretical Considerations

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ABSTRACT

Interaction design of pervasive and ubiquitous computing (UC) systems must take into account physico-spatial issues as technology is implemented into our physical surroundings. In this paper we discuss how one conceptual framework for understanding interaction in context, Activity Theory (AT), frames the role of space. We point to the fact that AT treats space primarily in terms of analyzing the role of space before designing IT-systems and evaluating spatial effects of IT-systems in use contexts after the design phase. We consequently identify a gap in that role of space is not recognized in the design process.

We address this gap by discussing the role of physical space in relation to key concepts of AT in terms of how an increased awareness of physico-spatial aspects influences the understanding and design of IT systems.

Author Keywords

Activity, Space, Interaction Design, Activity Theory.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

With ubiquitous computing, the traditional computer forms change and become part of our physical space. Information technology can be construed as primarily temporal as it is essentially constituted by the dynamics of executing program code. Consequently, IT has traditionally been considered non-spatial and non material. But as computation manifests its expressions in the spatial, physical realm, we have increasingly come to work with spatial IT-artefacts. Though, physical space has not been a major topic in traditional human-computer interaction (HCI). The embedding of information systems into our physical surroundings makes an understanding of space in relation to computer mediated activities pertinent for interaction designers. While HCI has traditionally been oriented towards task completion [13], interaction design can be understood as an activity oriented discipline: in interaction design there is a focus on ongoing activities and the experience of interacting with the system [11]. In line with this, an important distinction can be made between HCI as empirical science and interaction design as design practice [7]. In HCI there is a strong focus on empirical usability studies where design is seen as the mere derivative of analysis. However, the problem of turning analysis into design remains in HCI.

As practitioners within a Nordic information systems design tradition, we are inspired by activity theoretical perspectives [4, 10], and we consider ourselves interaction designers in that we design what Winograd [13] dubbed interspaces, assemblages of interfaces, actors and environments. We thus regard the challenge of ubiquitous computing interaction design as the design of spaces for human communication and interaction. In this paper, we address the issue of space and physical surroundings and discuss how an activity-centered approach to interaction design frame the role of space.

We discuss the role of space in an activity-centered approach to interaction design, namely Activity Theory [4, 10]. AT emphasizes the importance of space in interaction, but address spatial issues only in domain studies prior to the design of information systems, or after the systems have been introduced into the domain.

What is seemingly left open and unexplored is the issue of how to understand and work with spatial issues and the gap between these two phases, namely in the design process itself. This is obviously problematic for interaction designers: these spatial issues do not resolve themselves, and it must at least in part be the responsibility of conscientious designers to contribute to the configuration of the environment of interspaces as well as that of interfaces. Based in Schön's [12] notion of the design process as a dialogue between the design situation and the reflective designer drawing upon a repertoire of knowledge, we will argue that design experiments are key to gaining insights into physico-spatial design issues, and propose that insights from the realm of architecture may inspire interspace designers. This may lead not only to a better understanding of spatial issues in the design phase, but also inform the analytical phases before and after the design phase.

The rest of the paper is organized as follows: Next some background to AT and space, and to pysico-spatial issues in the design process, followed by a discussion on conceptual understandings and design considerations for physico-spatial surroundings. Finally, some concluding remarks.

BACKGROUND: ACTIVITY AND SPACE

For two decades, the Activity Theory framework has gained increasing popularity within IT-design [4, 10]. In the perspective of Activity Theory, activities are construed as the total of subjects, objects, mediators, physical surroundings and socio-cultural circumstances. The spatial and physical environment is thus an implicit part of any activity. In this perspective, subjects use mediating tools to manipulate objects to achieve intended outcomes. The mediating tools, objects and outcomes may be immaterial (such as mental calculations based on algebraic rules-of-thumb in order to guesstimate the sum of a grocery bill), however activities are generally carried out in order to effectuate a material reconfiguration in the acting subject's environment. Material surroundings also play an important role in regard to perception and cognition, in that subjects externalize mental conceptions and intentions through activities, and furthermore internalize knowledge acquired through the perception and understanding of physical surroundings and artefacts. Spatial configurations and physical artefacts can thus be understood as the crystallization of activities through historical processes, mediation, externalization and internalization.

Physico-spatial issues in the design process

The activity-oriented approach described above stress the importance of understanding the role of space in activity. However, the approach primarily offers a framework for analyzing and understanding these relations rather than action-oriented guiding principles for practitioners engaged in the design process.

A number of activity theoretical studies of information systems have been carried out to present analyses of information systems in particular physio-spatial settings, such as [3]. In [2] Bertelsen however points out that Activity Theory has mostly been applied as a conceptual framework for researchers, and that there is a gap between academic activity theorizing and practical design. Therefore Activity Theory has not quite succeeded in being a genuine resource for practical design. Design practitioners thus have few, if any activity theoretical resources to draw upon when wrestling with physico-spatial issues in the design process.

PHYSICO-SPATIAL CONSIDERATIONS FOR IT DESIGN

Based on the six basic AT concepts presented in [8], namely *consciousness & activity, object-orientedness, structure of activity, internalization-externalization, mediation,* and *development*, we initiate a discussion of conceptual understandings of physico-spatial surroundings and some considerations for design of ubiquitous computing systems. The discussion of these concepts is summarized in Table 1. Due to the scope of this paper, we do not offer an introduction to the six basic concepts – for this, we refer to [10]. Rather, we discuss them specifically in the light of ubiquitous computing systems in physico-spatial surroundings.

Unity of consciousness and activity

Physical space frames most ubiquitous computing *activities,* and by implication also the *consciousness* of the users partaking in such activities.

It is vital to incorporate all aspects of the domain space into the design process. Means of doing this, except for traditional studies, interviews and so on, is to bring spatial representations into the design process. Design representations that embody physico-spatial aspects of the interspaces being designed can take various shapes throughout the design process and may encompass aesthetic and affective aspects of interspaces as well as instrumental and functional aspects. There is a need in interaction design for understandings of how both the augmented and the physical spatial layout effects the users' experience and the users' behavior and social relations. Adapting understandings of physical space into ubiquitous computing interaction design, both in the design process as well as in the designed artifact, may yield new ways of understanding activities and use. Architectural models, both in the shape of physical foam-core models and virtual 3D models, are one example of this kind of spatial representations. Such physical and digital models are an embodiment of the design process, where alternative designs and design decisions are represented in different forms. Prototypes in interaction design traditionally demonstrate and explore interaction with a focus on functionality, whereas models in architecture often serve to provide visual overviews and understandings of the entire space in which spatial forms and users will co-exist in the performance of activities. Physico-spatial design representations may expand the functional focus of traditional prototypes and serve as vehicles for communication, exploration, and understanding. As such, these representations supplement not only prototypes, but also design representations such as mock-ups [5], storyboards, scenarios etc. Another approach to incorporate all aspects of the domain space into the design process is to carry it out in situ. The advantages with performing design sessions or even the entire design process in the right domain space is further described in [6].

	Conceptual understanding of ubiquitous computing systems in physico-spatial surroundings	Some considerations for design of ubiquitous computing systems in physico-spatial surroundings
Unity of consciousness & activity	Physical space frames most ubiquitous computing activities and thereby also frames the consciousness of users.	Incorporate perspectives and understandings of domain space into the design process. Bring spatial representations into the design process. Carry out design sessions in situ.
Object-orientedness	Activity is directed towards objects that may be physico-spatial and activity often concerns the ongoing engagement towards adapting to or transforming physico-spatial configurations	Consider how the users may decipher the activity space of applications, devices and other users/actors, how they may anticipate effects manipulating the object of their activity, and how this may change the activity itself.
Structure of activity	Physico-spatial surroundings influence activities on multiple levels – activities, actions and operations - as well as the motives, goals and circumstances for acting.	Consider motives for using UC devices and applications. Consider goals to achieve with devices and applications. Consider affordances and constraints as circumstances for using devices and applications.
Internalization-externalization	Space frames internalization and is in itself internalized in terms of spatial literacy. Externalizations take place in and may be directed towards physical space.	Consider how users make sense of UC devices and applications as part of a physico-spatial surroundings. Consider possible ways of using devices and applications to reconfigure physico-spatial surroundings.
Mediation	Spatial surroundings can mediate activity as well as tools and concepts.	Consider how space may serve as mediator for activity in combination or convergence (or possibly in opposition to) mediating devices and applications.
Development	Physico-spatial surroundings evolve over time as crystallizations of and frames for certain types of activities.	Consider existing tools, habits and physical constraints as sources of inspiration and the base for new UC systems and interaction Consider how devices and applications may adapt to and/or co-evolve with changing physico-spatial configurations.

Table 1: Activity-theoretical concepts and physico-spatial surroundings

Object-orientedness

Activity is directed towards achieving an outcome by transforming the object of the activity. Due to their nature of being spatially distributed and often mobile, ubiquitous computing devices and applications are frequently employed to achieve outcomes related to physico-spatial configurations, such as bring together the right people at the right time as in [1]. Practical design implications thus include explorations of how users may decipher the activity space of applications, devices and other users/actors, and how they may anticipate effects manipulating the object of their activity. During the process of the activity, the activity itself may change due to changes in the subjects' conception of the activity, changes in the mediating tools, or possibly in the object of activity. Design considerations also entail how to respond to such transformations of activities.

Structure of activity

The configuration of physico-spatial surroundings frame and influence activities on a number of levels. On the level of activities, aspects of this configuration may constitute the motive for carrying out activities; on the level of actions, goals may concern navigating in and/or reconfiguring parts of the physical environment; on the level of operations, the physico-spatial circumstances of operations may afford or constrain operations. For designers of ubiquitous computing systems, this multi-levelled perspective on activities means that design considerations not only regard the concrete constraints and affordances of interfaces, but also the goals for interacting with devices, and indeed the very motivations for using them in certain spaces.

Internalization-externalization

The process of internalization is often influenced by the physico-spatial environment in which it takes place. In some cases the internalization process may even be directly concerned with spatial surroundings, forming so-called *spatial literacy*, ie. concepts and understandings of human beings' relation to their physico-spatial surroundings [9]. Reciprocally, externalization of intra-mental processes are often directed towards affecting - and in most cases are visible as reconfigurations of - the subject's physical surroundings. For designers, this on the one hand calls for exploring how users make sense of devices as part their physico-spatial surroundings, and on the other hand calls for explorations of how devices and applications may allow for reconceptualizations and reconfigurations of users' surroundings.

Mediation

Spatial configurations can mediate activities just as can tools. Such configurations may even be considered tools, eg. hotel lobbies mediate transitional activities of arrival and departure, auditoriums mediate lecture activities etc. For designers, this on the one hand requires insight into the types of mediation that is always already taking place in the domain for which one designs. On the other hand, it prompts considerations regarding how reconfigurations of space may affect existing mediating processes and initiate new ones.

Development

Considering the activity theoretical concept of *development*, physico-spatial surroundings evolve over time as crystallizations of and frames for certain types of activities. Returning to the concept of spatial literacy, cultures over time develop physical spaces for certain activities, as well as narratives and literacies that complement them. As means for design, it is important to consider what is already out there in the physico-spatial surrounding, and to consider these tools, habits and physical constraints as inspiration and the base for ubiquitous computing systems and interactions. One aspect of this implies consideration of how devices and applications may adapt to and/or co-evolve with changing physico-spatial configurations.The nature of a design material is its ability to take up new forms or relate to other materials in new ways shifting its initial function. The primary interaction design material, IT, has been construed as non-physical, however, when designing spatial interfaces, physical materials come into play and designers must understand how the properties of IT relate to spatial properties and boundaries as design materials.

CONCLUSION AND FUTURE WORK

In this paper, we have argued that there is a growing need for understanding the physico-spatial surroundings for ubiquitous computing interaction design. We have therefore presented a discussion of physico-spatial concepts and considerations for design using basic activity theoretical concepts. Our discussion is cursory and initial, and it prompts future expansion and experiments to elaborate and further develop both the conceptual perspectives and the design-oriented considerations.

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Mobile Gaming and the challenge of complex technology

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ABSTRACT
Developing and play testing mobile games we are facing novel challenges for understanding and designing interfaces for human-computer interaction: complex technology and emotion. In this paper I describe the challenge of complex technology within our research on mobile gaming experiences by referring to our prototype, the mobile game On the Streets we are still developing. I describe the game technology, the thereby provided game possibilities and the problems revealed by the last play-test. In a further step I introduce the activity theory, describe characteristics of the mobile gaming activities and experiences we have found till now and outline our approach to the mentioned problems.

Author Keywords
Complex technology, mobile gaming, experience, activity theory, interface design, human-computer interaction.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. H.1.2 [Information Systems]: User/Machine Systems—Software Psychology.

INTRODUCTION

At the center of our research activities are mobile gaming experiences and their conceptual, technological and aesthetical foundations. Developing and play testing mobile games we are facing novel challenges for understanding and designing interfaces for human-computer interaction as for example complex technology and emotion [1]. Emotion is a necessary part of game design. A game may seduce gamers first for attending a game and second for playing throughout the whole game. Thus game design has to take into account player emotions by means of designing the mechanics, dynamics and aesthetics of a game [3].

In this paper I describe the challenge of complex technology by referring to a prototype of a mobile game, the game On the Streets we are still developing. I start with a presentation of the game and then describe the game technology, the thereby provided game possibilities and the problems we are facing now after the first play-tests. I introduce then a process-oriented concept of activity for understanding experience, process dynamics and development in the use of technology [3]. In a further step I outline our approach for solving the mentioned problems with reference to characteristics of the play activity we have observed.

THE MOBILE GAME ON THE STREETS

Mobile Games are defined by the physical movements of a their players, the combination of the physical and a virtual world in one game world and the use of computer technology.

The players of the mobile game On the Streets are organized in gangs. Each gang consists of several runners and one boss. The game world is a physical area - for example the inner city of Bremen – combined with a virtual map providing contextual game possibilities. The physical area is divided into fields by a virtual grid visualized at the map. Some fields provide specified game possibilities explained below. Each gang has a virtual homebase located at one field. The game goal of a gang is to conquer fields. The winner is the gang possessing most of the fields or possessing most of the other homebases. The runners act and conquer fields by their physical movements or if they meet another owner of a field at that field by means of a virtual fight. The bosses sitting at a PC and looking at the map act by analytical observations, strategically orientation and coordination of runners. The gang members communicate with each other via PoC phones.

GAME TECHNOLOGY AND GAME POSSIBILITIES

The game concept is elementary regarding the Mixed Reality but complex regarding the different devices and technologies involved.

Complex technology

The runners use PDAs, the clients in the client-sever system, GPS, GPRS and PoC phones. The PDA-client, the Server, GPS and GPRS build an integrated infrastructure and have to operate together fluently. The PoC phones the players are using are not integrated devices.

The bosses use PC-clients in the client-sever system and the PoC phone.

Mixed Reality

The game world consists of the physical area and a virtual map providing contextual game possibilities. The physical area is virtually marked by information visible at the map displayed for the runner at the PDA and for the boss at the PC:

- Field definition of the physical area
- Fields possessed by the own gang
- Content of a field: items to be collected for later use like med packs and stroke-proof waistcoats (see below)
- Properties of specified fields: Bank, Hospital
- Presence of enemies and robots at the actual field a player has moved to.

Thus the virtual world in this game is reduced to a map, providing contextual game possibilities. Regarding the Mixed Reality Continuum from Milgram the game world can be defined in this case as Augmented Reality [5].

The runners perceive the mentioned information at the PDA displaying a map of only their direct environment of eight fields, surrounding the center field the player has moved to.

At the PC the bosses perceive the whole map with the mentioned information and see additionally the movement of the runners of the own gang, the energy status of all gang members, the budget to finance the buy of robots and the robots stocked.

The virtual world mediates also actions of the players. For achieving the game goal the player can use local game possibilities in addition to those described in the game concept above: they can conquer a bank (-field) for assuring regular income for the boss to buy robots; they can recharge their life energy by stepping on hospital fields or by using med packs; they can collect items in those fields their gang owns, med packs and stroke-proof waistcoats, and they can use use them if needed; the bosses can defend own fields by means of buying and installing robots at particular fields.

For fighting the players have to be in the same field as the enemy. To start a fight a player has to select this enemy. She can do so only by identifying the physical enemy and the colors of his shirt and his cap. The fight mechanism between them is a virtual mechanism. The attacker perceives her enemy at the PDA as a virtual figure with three contact surfaces: head, body and legs. She has to select one contact surface for attack, while the defender has to select one of the three contact surfaces for shielding. The fight is turn based: the first player attacks, the second player defends within a certain time limit and vice versa at the next turn.

The attacker wins as soon as the defender selects the wrong contact surface. The defender loses then a certain amount of life energy. Regarding the Mixed Reality Continuum from Milgram our game world can be defined in this case as Augmented Virtuality [5].

The perception of physical and social phenomena and the physical movement of the players have an impact on the mode of functioning of the virtual mechanism. Opening and ending of a fight depend on the physical movement of the player and their presence in the actual field. The conduct of the fight depends also on the perception of what the enemy is doing and how he is acting. The process of a player's decision making and her perception of the result of a fight can be accompanied by expressive utterances of a player, what the enemy can interpret and take into account regarding his own activity.

Current problems of development

After the first phase of the technical development we play-tested the game On the Streets and found two kind of problems: (1) performance and scalability problems and (2) problems of the interface design.

- Play-tests with four to six player have been successful. The first test with more then ten players revealed performance problems. They happened always when many game events had to be computed in a short time. In the literature we found many hints to performance and scalability problems within mobile applications and particularly network applications. But none of them seemed to be helpful in our situation.
- Till now the whole game is organized as one event to be managed by a staff of experts. The planning, the preparation, the organization of the game is demanding an impressive amount of time and power resources for management and technical support. We are heading for a game with a simplified organization or even a self-organized format. For this transition we need a design of the interface and the interaction, which supports the player to maintain the general technical conditions by themselves.

MOBILE PLAY ACTIVITY AND GAMING EXPERIENCE

Process-oriented Activity Theory

We work with a process-oriented model of the activity theory [4] in the tradition of Vygotsky and Leontjew. We found the following characteristics of this concept distinctive:

- Activity is not only productive but also reproductive. The actor reproduces himself and his relations to the world within and by activity.
- Activity is always at least instrumental and social. The actor reproduces by activity her instrumental and social relations to the world.
- Each activity has a double character: structure and context.

- The structure of an activity comes into being within and by the accordance of subjective and objective conditions with reference to the motif of activity. This dimension reflects on the foreseeable and repeatable dimension of activity. This dimension includes also technical and economical structures as well as cognitive structures and the logical reasoning of the actor.
- The context of an activity comes into being within and by the differences of subjective and objective conditions and their interaction and reflects on the unexpected events within and by activity. This dimension includes intuition and emotion of the actor.

This concept of activity is pointing to the unity of even logical incompatible qualities, contradictions. They are understood as the source of motion, imagination, innovation and development. Basic contradictions of each activity are described by the preceding assumptions: production and reproduction, foreseen and unexpected, instrumental and social, rational and intuitive. This concept of activity is designed to allow plural forms of theory building and (trans-) cultural design strategies.

Shifting between the virtual and the physical world

In difference to the play activity in other games as there are board games, online games or outdoor games the focus of the play activity within a mobile game is shifting between the virtual and the physical world.

The relation between the both worlds, the virtual and the real or physical is defined by the game technology. But the coherence of the game world as a whole has to be actively maintained by the players themselves.

Maintaining the Magic Circle

The magic circle separates the game world from the surrounding environment (7). The traditional understanding of the magic circle is challenged by mobile games as Montola and the IPERG Project found out [6]. The spatial, temporal, and social limitations of the game world are becoming permeable to that extent that if one limitation vanishes the game is no game anymore. This phenomenon reveals that the magic circle is not only defined by the game technology but has to be regularly and actively created and maintained by the players.

Within the play activity of the players of On the Streets we found different kinds of actions during the game play: the first kind followed immediately the game logic, the second kind served the creation and maintenance of the magic circle by assuring the general conditions of the game with reference to the concrete contextual conditions of the game play.

Thus the activity of a player consisted on the one hand in immediate actions regarding the game logic:

- Physical movements and changing contexts
- Orientation, perception and comprehension of situations and game possibilities
- Decision making on game options
- Completing actions
- Evaluation of (interim-) results
- Communication with other players according to the game logic

The activity of the players consisted on the other hand in actions of creating, maintaining and shaping the Magic Circle regarding its spatial, temporal, and social limitations under the concrete conditions of the game play:

- Physical interaction and communication between enemies preceding and accompanying the fight to enable the fight
- Acceptance and individual compensation of technical shortcomings of the game world as for example a feedback delay
- Help for each other for interpretation and social support in coping with technical shortcomings

These kinds of actions are particularly related to the concrete conditions of the game play.

The interplay of the both kinds of actions seems to be related to activity as a productive and reproductive process.

Empirical Study of gaming experience

We currently study data on mobile play activities and gaming experiences, we collected within the test of the core-mechanism, an elementary version of the game On the Streets with four players on four fields [3]. We study the game process, the processes of the play activities of the two gangs and the four singular players and we study their gaming experiences.

The characteristics of the play activity and the gaming experience we mentioned above can be demonstrated for all the different phases of the game play in sequence.

GAME, TECHNOLOGY AND INTERFACE DESIGN

Since some weeks we try to overcome the mentioned technical shortcomings revealed by the last play-test and prepare a further test with 24 players in the beginning of May 2007.

Mobile game event

We assume that one (!) reason for the human-inter action problems and the related performance and scalability problems I reported above is a shortcoming in our understanding of a mobile game event.

Our technical definition of a mobile game event and the activity-centered definition of a mobile game event are insufficient conceptualized and synchronized till now.

The mobile game event as it turns out to be for the player and his play activity, requires a certain time and a certain amount of effort needed particularly in mobile games in difference to other games. For altering the game status in our mobile game by changing the field, the player needs another amount of time for traversing the physical space than a player in a board game or a computer game needs for traversing the physical space by hand movement for altering the game status.

In our software system the technical defined game events are atomized till now to smallest units of change of a game status. The reason was the interest to build a general system applicable for different kinds of games not only mobile games. The dissection of a coherent game event in smallest technical units, initializing themselves further internal technical game events, has lead to the consequence that the consistency of the mobile gaming experience from the player perspective cannot be assured as soon as a certain amount of players is engaged in the game.

Currently we work for solving the performance and scalability problems. Regarding the game event we re-structure and re-contextualize the technical system with respect to the mobile game event from the perspective of the players activity.

Self-organization of the mobile game

Facing technical problems throughout the game play the player till now help needs from technical experts. He has to look for them as soon as he gets signals he cannot interpret by himself. In the next step we want to enable the players to solve problems like an abnormal system end or the interruption of the GPS connection by themselves.

The transition from the management format of our game to a format of a simplified organization or even a self-organization of the game requires – from the perspective of activity theory – to support the player for self maintaining the general conditions of the game play on the technical level. One step in this direction is

- Make the invisible requirements of the game play in this problem situation transparent for the player and
- Support the player to restore the technical requirements themselves by means of guiding them through the interface.

Another concept to overcome technical breaks of the game flow, which also makes sense from the perspective of the play activity, is the concept seams [2]. We face for example within our next development phase the problem of transition between WLAN positioning and GPS positioning in the beginning of a game play. The cold start of GPS positioning needs a certain amount of time of roundabout two minutes. This phenomenon may destroy the game-flow. But players and designers are able to cope with this technical problem. Players themselves may exploit this possibility for tactical reasons. Designers may integrate the transition phase into the game concept for example by installing a game zone for particular game actions, in which both technologies are functioning concurrently. Within this game zone play actions may need the minimal time of two minutes to be conducted thus allowing the transition. Seams may enhance the possibilities for game design.

CONCLUSION

The use of complex technologies like mobile technology requires possibilities of fluent changes within the own activity system, between levels, contexts and foci of activity. The design of interfaces for the use of complex technologies depends on a deep understanding of activity processes.

ACKNOWLEDGEMENTS

I thank Sonja Gröning, the second developer of the game server, for discussions about the performance and scalability problems and Florian Schaper, the first developer of the game server. I thank my PhD-students, Miriam Oks, conducting the empirical studies of the play-test, for discussions on the mobile play activity and gaming experience, and Juliane Schulz, preparing the project on the cultural impact on mobile play activities.

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Towards an Instrumental Paradigm for Ubiquitous Interaction

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ABSTRACT
This paper elucidates the limitations of classical conceptual models and concepts for developing interactive systems on a personal computer, when moving towards design of ubiquitous user interfaces. The paper proposes a disintegration of the monolithic application concept into detached interactional instruments, creating a base for interface distribution and dynamic adaptation of tools to the use setting and point towards how we intend to realize a system based on this interactional paradigm.

Author Keywords
HCI, Ubiquitous Interaction, Ubiquitous Computing, Instrumental Interaction, Pervasive Computing, Mobility, Distributed Interfaces

INTRODUCTION
Ubiquitous interaction – interaction in pervasive, ubiquitous, tangible, or ambient computing – including interaction with multiple, and dynamically distributed interfaces, is an area where there is very little coherent theory to guide design. Nor are there any well-established metaphorical approaches or conceptual models to rely on when designing for ubiquitous interaction. The new developments of ubiquitous user interfaces challenge both our understanding of human computer interaction as one technology – one user, which has been the previously predominant scope of HCI theory and challenge the fundamental assumptions underlying contemporary graphical user interfaces.

The WIMP paradigm and the desktop metaphor are still predominant in most interaction systems, but they are based on an assumption of a fixed set of input/output devices and a user situated at an office desk. Since the introduction of the PC, the ways we understand software tools have inseparably been bound to the device confining it, and software tools are mainly developed with a specific device in mind. Even though these assumptions contrast the goals of ubiquitous interaction – multiplicity, dynamism and distribution – these assumptions of user interaction from WIMP and the desktop metaphor often shine through novel design. A obvious cause for this is simply the lack of alternatives and that the devices and their operating systems used in such systems are commonly individually designed with roots in the old assumptions.

In this paper, I will give a critique of the conceptual models of classical user interaction on a personal computer when broadened to a context of ubiquitous interaction. Subsequently, I will discuss alternatives to central interactional constructs and discuss the approach we in the UUID (Ubiquitous User Interface Design) group will take towards an implementing prototypes following an instrumental paradigm for ubiquitous interaction.

TOOLS
One of the the main goals in creating ubiquitous interaction, is supporting fluent interaction with distributed interfaces and interaction in dynamic configurations of interfaces distributed on various technological artifacts. Hence, interaction should be supported not only in the office, but fluently between being stationary and being mobile, thereby not rely on a single encapsulating personal computer – or any specific pre-assumed device for that matter. To achieve this, access to the same palette of tools and objects across different devices become necessary. Today, devices do not share the same tools, but the same *kind* of tools. A PDA might have a text editor implementation with some of the same features of an implementation of the editor on a personal computer – but they are rarely the same. There are many reasons why the *same kind* is a problem: the tool has to be implemented on each device, an exact copy of functionality is hard to achieve, and the user has to learn to use the alternate implementation. Of course, it would not be feasible to have the exact same tools on a PDA as on a personal computer – the PDA is limited in ways preventing the complexity of interaction possible on the PC. But it would make sense to have a subset of the same tools on e.g. the PDA as on the PC. To support the above goal of ubiquitous interaction, Software tools should be decoupled from specific hardware devices to support dynamic distribution of tools from one device to another, e.g. the use of the same text editing tools on a PC and a PDA.

Tools on the personal computer and beyond
The predominant way of handling tools on a personal computer is by encapsulation in applications. It is hard to find a direct counterpart to applications in the real world. Applications can resemble a collection of tools gathered to perform a certain task in the physical world – the architect or the painters tools – but an application lacks the dynamics of such a collection. A brush in an application can seldomly be removed and used in another context. The specific set of tools in an application is predefined by the software developer. It is not possible for the user to reconfigure the set of tools for

her own personalised needs on a low level. Nevertheless the application prevails as a central concept of today's computer use, both as a commercial construct and as *the* way of using a personal computer.
The file types bound to applications are, likewise, an artificial construct compared to the materials of the physical world. A specific application is often needed to manipulate a given file, and there is no logical connection between tool and material. This inflexibility poses a limitation on supporting mobility, distribution and customisability of interfaces. The large applications, built for general purpose personal computers, are not necessarily suitable for smaller devices, or devices with other kinds of inputs. Device specific applications are therefore required, which might be radically differently implemented across different platforms and technologies. Neither do applications offer much choice in features – you either choose the whole package, or something completely different.
In a discussion of software customization, Carter [4] addresses the way architects handle their tools at the drawing board. The work is performed with a wide range of tools, each with a narrow range of built-in flexibility. A pencil can be angled to draw thicker lines. These tools are independent, but can be used together to produce complex drawings [4]. The pencil the architect uses, is not only usable for architect drawings; it can also be used to write her grocery-list, or by her children to draw on the wall. The tools used by the architect are not locked to the drawing board, she can pick up a drawing and a few basic tools and use them to annotate the drawing on the way home in the train. Carter argues that this unitary nature of tools is of importance for the fluid and on-going adaptation of the work-space to the task. This is a flexibility which is missing in the current monolithic application structure, but never the less it is a flexibility which would fit the goals of ubiquitous interaction.
Michel Beaudoin-Lafon [1] similarly advocate for gathering commands in instruments to resemble the way we naturally use tools (or instruments) to manipulate objects of interest in the physical world. Beaudoin-Lafon describes graphical user interfaces in terms of interaction instruments mediating interaction with domain objects. An *interaction instrument* is defined as:

> *... a mediator or two-way transducer between the user and domain objects. The user acts on the instrument, which transforms the user's actions into commands affecting relevant target domain objects. Instruments have reactions enabling users to control their actions on the instrument, and provide feedback as the command is carried out on target objects.* [1]

Beaudoin-Lafon's concept of interaction instruments is quite compatible with Carter's thoughts of giving computer tools a unitary and flexible nature, and the thought of completely disintegrating the application construct, and instead thinking of dynamic configurations of instruments to perform complex interaction, and facilitating easy distribution of these instruments over multiple technologies.
The charm of physical tools with limited properties is the easiness of decoding the actions afforded by the environment when the tool is grasped. A surface of basically any kind affords to be written on with a pen[1]. To achieve this in a computing environment, one would have to rethink the way we represent our data, files and documents. Creating the same kind of affordances as in the physical world would require a simulation of a small Gibsonesque ecological reality [5], where afforded actions were not hard-coded, but consequences of the relationship between the domain objects and the properties of the interaction instruments. In this line of thought, the domain object should not be specified by a specific type, but instead by properties resembling physical properties. For instance, an object specified as being a two dimensional surface, a three-dimensional geometry, or two-dimensional surfaces associated with a temporal dimension etc. Interaction instruments should be defined by what they act upon, and how and what they modify through use. As an example, a simple drawing tool would be able to draw lines on a surface, a text editing tool would manipulate and write text on a surface and ruler tool could measure distance on a surface with an associated unit and scale.
Applications for a personal computer are geared towards interaction with a mouse or a keyboard, but today with the versatility of devices, one can no longer assume the mouse and keyboard to be the only input devices, and one can only guess of the character of future input devices. Input devices should be defined on a more general level, specifying what they can manipulate and how. A mouse and an analogue joystick both control a two dimensional speed vector.
The liberation of domain objects (file types) from specific static sets of instruments (applications), and the liberation of the instruments from specific input devices would let the user be able to rely on the relational affordances between physical and logical instruments and logical instruments and domain objects. This liberation would also support the mobility of the above described scenario. Ideally, the architect would be able to work on a general purpose computer simulating his drawing board, interacting with a large configuration of tools, and then move a few of the tools and some domain objects to a handheld device for editing and annotation on the way home. Thus, he maintains a consistent interaction customised to his needs with a subset of the tools from his workstation.

REALIZATION AND FUTURE WORK

In this section, I will sketch ideas for realizing a system based on instrumental interaction supporting ubiquitous interaction. I will discuss our approach in the UUID group to implementing prototypes following this paradigm.
Realizing a system for supporting the kind of instrumental ubiquitous interaction, as discussed above, is a compound problem. Some of the fundamental problems is how to design an object model, how to represent objects to the user, and implementing the interplay between instruments and objects while preserving the decoupling between these. Beaudoux and Beaudoin-Lafon [2] discuss a model tackling some of these problems in a way easily fitting the problem area of ubiquitous interaction. Grounded in Beaudoin-Lafon's [1] ideas of instrumental interaction, Beaudoux and Beaudoin-Lafon [2] present a model for document centered interacti-

[1] Given it is culturally and socially accepted.

on[2] where they combine a document model compatible with XML with an interaction model based on instrumental interaction. The decoupling between logical instruments and documents is by Beaudoux and Beaudoin-Lafon achieved by letting instruments be bound to properties of documents, rather then the document it self. A move-instrument would be able to modify the position of objects in a document, while a text-instrument would alter text fields. The properties edited with a given instrument is chosen through the presentation of the document, but the instrument alters the document directly, bypassing the presentation.

This kind of separation is not completely compatible with an ecological understanding of interaction, instruments are still bound to a certain domain – the properties they can alter – but the main difference from an application centric approach is that these instruments can modify any kind of documents having the property compatible with the instrument. By decoupling the functionality for interacting with documents from the document, and merely letting the presentation be a visualization of the document and means for selecting parts of it, it is possible for instruments to work on a range of different presentations of documents. This is an interesting observation in the context of ubiquitous interaction, since presenting documents in the same way across vastly different devices is impossible, but supporting alteration of an XML structure given some input and a pointer to a part of the structure is possible on any kind of device with a minimum amount of processing capabilities. Hence the user will have the possibility access to the *same* tools across devices instead of just the *same kind*.

Another aspect breaking with perception in the sense of Gibson [5], is digital representation of objects. Beaudoux and Beaudoin-Lafon state that documents in a physical sense have two overall facets, namely *persistence* and *presentation* whereas in a digital domain this is separated. An advantage of decoupling persistence from presentation is the possibility of multiple views of the same document – but this advantage breaks with the physical document metaphor. To hide this decoupling, [2] suggest making alternate presentations active, meaning that presentations are synchronously updated when the document is altered – hereby giving the user the a sense of that the multiple presentations actually *is* referring to the same object. Multiple presentations naturally open up for the possibilities of shared editing, which is essential for supporting ubiquitous interaction, not only interpersonal sharing, but also realtime sharing across different devices.

It is our intentions to implement a system supporting instrumental ubiquitous interaction, and develop prototypes e.g. realizing a scenario similar to the architect scenario discussed in the previous section. Currently, we are implementing an object model inspired by the one suggested by Beaudoux and Beaudoin-Lafon [2] and we are working conceptually developing how instruments should be handled. Beaudoux and Beaudoin-Lafon base the interaction flow in their model on concepts from Norman's action theory [6] whereas we rely on the activity theoretical understanding of instruments and human action [3], where operations in activity theoretical sense is the fundamental component in the interaction from the user – a discussion outside the scope of this paper. To support the distribution of instruments and objects we intent to join the object model and the implementation of instrumental interaction with an infrastructure for ubiquitous computing developed locally at the Department of Computer Science in Aarhus.

There are many question regarding an actually implementation that is still unanswered, and will be hard to answer before the more fundamental parts have been developed. Questions such as: How is configurations of instruments handled, and how are they presented to the users? What level of functionality is required by an instrument? How can communication with other people be thought into the instrumental paradigm? And of course a range of question regarding the actual usability of such systems can't be answered before prototypes mature enough for obtaining empirical results from experiments with real users.

I believe the new developments of ubiquitous interaction, and other novel forms of interaction, force us to reconsider the fundamental concepts underlying our interaction with computers. In this paper, I have presented some initial ideas towards rethinking the conceptual models for interaction to suit the characteristics of ubiquitous interaction and sketched and approach towards realizing a system based on an instrumental paradigm for ubiquitous interaction.

ACKNOWLEDGMENTS

I thank Michel Beaudoin-Lafon, Susanne Bødker, Olav Bertelsen, Christina Brodersen and Bent Guldbjerg Christensen for valuable input and discussions.

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[2] In contrast to application centered interaction

Moving beyond space, place and context in HCI

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ABSTRACT

This paper argues from a product design perspective, that it is necessary to use a holistic approach to understand the designsetting of wireless networked products. Instead of discussions on space, place and context which has been a central issue in HCI, the notion of habitats seems much more useful for encompassing the complex setting of people, artefacts, space and place, information, interaction and experience. By taking starting point in the design of a biomonitor for use in emergency rescue response, this paper shows how complexity is increased when devices become wireless and networked, and shows how the notion of the habitat can be used to frame the complexity of the designchallenge. Not only as a tool for bridging the gap between different disciplines, but also as a concept for framing the complexity of interaction in a wireless networked environment.

General Terms

Design, designtheory,

Keywords

Habitats, product design, wireless networks.

1. INTRODUCTION

Designing for wireless networked systems is challenging and complex. A successful design calls for interdisciplinary work between system designers, product designers and interaction designers. However, this happens far too seldom, which in return results in systems which: 1) Do not take into account the physical artifacts in use and the interaction required. 2) Wires have been removed and replaced with wireless connections but no other consideration for the potentials of networked devices has been taken into consideration. 3) Interaction is only designed for one specific predefined situation.

However, even though the before mentioned professionals cooperate closely and combine their skills, designing for wireless networked systems will always be very much related to what Rittel [1]) defined as wicked problems. In short, wicked problems are characterized by being ill-formulated, consisting of confusing information and by having many clients and decision makers involved. Chances of a design team coming up with a simple and generic solution are almost non-existent due to the complex nature of the design. What works in one setting, might not work in the next setting. The availability of the networks constantly change, and what works for one kind of users may be completely useless with another kind of users.

When going beyond the level of "one device – one application", questions arise such as; how do we define the limits of what we are to design, when the boundaries in a sense are limitless? How do we design artifacts and the connected interaction, when the same device can be used by several users with different professional or personal backgrounds – and sometimes simultaneously? Nevertheless, there are some principles and methods, which have been found useful through research done in the palcom [2] project.

In the following, an example from the palcom project is presented in order to illustrate the complex setting of a wireless networked device. Subsequently four fundamental requirements are listed for designing in these complex settings, leading to the argument of using the notion of habitats to frame the design space.

2 . The BlueBio biomonitor

The BlueBio biomonitor developed in the palcom project is an example of the complexity of the designchallenges encounetered by HCI and Industrial design.

The BlueBio biomonitor [3] is a wireless networked device for monitoring injured persons regarding pulse, respiration and blood circulation. The biomonitor has three sensors for measuring the patients ECG, a powersupply and a Bluetooth connection. The biomonitor is connected to a Basestation which receives the patient data, and transmits the signal to short-range devices in the vicinity via Bluetooth. The Basestation also transmits data via GPRS to the Acute Medical Coordination (AMC) central and to the relevant hospital. One Basestation can handle up to 20 biomonitors.

Currently, the Danish ambulances and Mobile Emergency Care Units (MECU) use the Lifepack 12. The Lifepack 12 has the size of a small flightcase and can be used for 12 point ECG, measure the bloodoxygen saturation and functions as a defebrilator. The Lifepack 12 is primarily designed for treatment of cardiac arrest, however it is often used primarily for its bloodoxymeter function, which provides essential information regarding bloodcirculation and pulse. The problem with the Lifepack 12 is its size weight, and the wiring between sensors and main unit, making it diffucult to use at larger scaled accidents and major incidents with mayb several hundred injured.

But making a device such as the Bluebio biomonitor smaller and wireless, is not enough. When capable of being used in a major incidenets, the design challenges rise. Suddenly it is not just a single user. Many users are involved, with different backgrounds and different requirements. Even though the various emergency personnel basically just wants to know:

1) If the patients condition is critical and needs instant treatment.

2) If the patient needs treatment but can wait.

3) If the patients condition is in a state where transportation to the hospital can wait until the rest have been taken care of.

- they all want access to the biomonitor data but at different levels. For example:

- The paramedics observing the injured want notifications of changing conditions of the patients, in order to respond to worsening conditions immediately.
- The coordinating physician on site wants a status overview of all the patients in order to coordinate hospital coordination with available resources in cooperation with AMC.
- AMC wants an overview of all the injured in order to communicate with the coordinating physician, and if resources are available to act as a third eye for the observation paramedics on site.
- The ambulance personnel transporting the patient, will want to monitor the specific patient during transportation as well as the staff at the trauma ward wants receive data from the ambulance in order prepare for appropriate treatment.

3. Implications for design, space, place and context

It is obvious that wireless networked products like the BlueBio biomonítor can not be designed without a profound knowledge of the use settings at all levels. This leads to four main issues all related to the understanding of the setting.

Firstly, the requirements of the different communities of practice must be realized, not only be the designers but also by the practitioners themselves. Wireless technology crosses boundaries between disciplines that may not earlier have had any direct communication, and it is necessary for these disciplines to meet and discuss requirements and wishes.

Secondly, there must be an overview of the technology available. What devices will come in use, which networks will potentially be available and how many will there be.

Thirdly, there must be a profound understanding of the places where the interaction will take place. There is a profound diffences between acting in an urban environment or a remote location in an open landscape. Infrastructures differ, as well as the acessability for vehicles, persons and equipment.

Fourthly, there must be an overview of the different types of information required and how and where should it be displayed. The same kind of information may need to be represented in different ways, according to the place and persons involved.

The notion of space, place, context and activity plays a central role in the above issues. These have been central issues for some time in the HCI, however, they can be interpreted in so many ways that they easily loose meaning in multidisciplinary settings. For example, architects often regard context as a property of the physical surroundings and surrounding infrastructure, while the notion of context is defined much broader in HCI where digital information can be the context of a physical loacation.

Place space and context, become problematic when they become distributed as for example in the biomonitor example. At a major incident a medic on site and a physician at a hospital can be monitoring the same data from an injured patient located in a place not visible for either of them. So is this assembly of information and interaction one place or 3 places, or is it actually not a place but a virtual place constructed for a specific purpose? And what about context in this example? Is context the accident site, the hospital or the whole setting. Furthermore is context static or dynamic. In [4] Dourish suggests that context is continually renegotiated and defined in the course of action. However, if construction is dynamic and can be constructed on the fly, and space and place is distributed and depends on the perspective of the viewer, this might be as true as it is in-operational for designers. Context constructed through interaction and a fluid definition of space and place cannot be designed for and are not very helpful for designers trying to frame a design space.

4. Habitats as a framework for design

When designing for wireless networked systems, a common framework encompassing the whole setting, could provide a platform for communication between the involved designers. A promising approach for this has been provided by [5] and [6] from a HCI perspective.

In [5] the authors propose an understanding of a digitally pervasive world as consisting of physical habitats, informational habitats and conceptual habitats.

- The physical habitat is the physical dimension of our reality.
- The informational habitat is created with - and exists in information (as for example a mail server).
- The conceptual habitat is defined in terms of concepts and ideas such as culture, which is ascribed by beliefs, customs and practices.

All though the framework is not mature, it can be utilized in an attempt to organize the emergency rescue setting with the biomonitor. This is described more thoroughly in [7], but in short:

- The physical habitats related to the BlueBio biomonitor can be defined as the accident site, the ambulance, the trauma ward and the AMC.
- The informational habitat can be defined by the biomonitor data.
- The conceptual habitat is defined by the different communities of practice such as ambulance staff, physicians from the MECU, hospital staff etc.

The three types of habitats and the relationship between them is of course much more complex, however the implications for the design are simple but important.

Too utilize the potential of wireless technology such as the BlueBio biomonitor, all three habitats and the connections between them should be taken into consideration. If the design is developed on the foundation of the three habitats, there is a chance that the physical design will comply with the physical requirements posed by the environment. Data could be distributed locally and externally and the complexity and history in the data representation, could be varied according to needs of several users in parallel. And finally, an exploitation of the conceptual habitat could provide the basis of for designing a system supporting telemedicine, in the sense that a nonproffesional helper on the site could be remotely guided by the physician located at a hospital.

5. Conclusion

The notion of habitats goes beyond different disciplines understanding of space, place and context. Habitats encompasses the physical, informational and conceptual activities and properties related to distributed wireless networks. However, using the framework of habitats is not a precondition for designing successful networked technology. In the same way the framework is not a formula which can guarantee a well functioning product. Nonetheless, the three levels should be identifiable in the design of wireless networked technology. As such, the notion of physical, informational and conceptual habitats could provide a good starting point for framing the human-computer interaction beyond the level of one-device one application.

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Multiple interfaces, examples from telephony

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ABSTRACT

We study the use of multiple terminals and many users in the context of 'calling to a home or family'. We use observed practices to enhance the published P3 framework by Jones et al. with some new concepts. Persons, roles, groups, places, mobility and activities are looked into, as well as some business aspects. In particular the case of multiple providers for the phones and the services may cause some problems. The paper also shows that interworking between fixed and mobile phones are not trouble free when 'calling a family'.

General Terms: mobility, telephony, user aspects,

1. Introduction

According to the workshop call, the HCI community originates in the paradigm of 'one device-one application'. We may also add that the focus has been on 'one user'. The author has her background in the telecom domain. One important feature in a telecom system is that we handle *at least two*[1] *users*, namely the caller and the callee. Already the old analogue phone system (POTS[2]) was able to handle multiple devices and multiple users at the same time, as will be described (see Case A).

This paper will focus on mobiles and new 'smart phones' with displays. A focus will be on multiple devices, multiple users and mobility (multiple places). Multimodality is not studied here. Several studies of (modern) telephone systems have been carried out in the field of CSCW, (see e.g. [2] and [5]). These studies have mostly been carried out in a professional (office) setting. We want to study *other settings* where the 'desk top' is not predominant, and we chose the domain of a 'family home'.

2. Methods

In this paper I will draw on existing applications[3] and examples of use of these applications as also done in [1]. This is in contrast to building new prototypes.

I will also refer to examples experienced by myself, starting some 40+ years back. This is an obvious source of 'wrong memory', however, since the oldest stories relate to 'normal phones in family setting', the reader should be able to use her own memory as well. Our method is thus (more or less in parallel) to conduct:

- Literature studies describing some use patterns of existing 'call applications' (such as fixed and mobile phones).
- Reconstruct some use patterns of the same from the 60ties and up until today.
- Via literature studies find relevant frameworks and concepts and enhance them based on the examples.

3. 'Calling to the home', existing practices

This chapter will be organized in chronological order. Each existing practice is called a case. Each case will be followed by a comment. The comments will relate to the concepts introduced later in chapter 4. Of course when looking back I will use some of today's words (such as caller-ID) when describing the cases.

3.1 Phone system (POTS) in the 60-70-ties:

I grew up in the 60'ies in a home without a phone. However, both of my grandparent's homes had phones, so I was already as a young child used to calling and answering calls, as well as to the use of public pay phones, and I knew phone numbers by heart.

Case A) Calling a family in the 60-ties: Auntie Annie is calling to my grannies (her relatives) fixed phone, because she knows (already from elsewhere) that my family is visiting my grandparents. Grandma picks up the phone and talks for some time to her relative, then my mother talks for a while, and then (all) the children talk to auntie.

Comments: As explained my family did not have a phone. For Annie to reach us calling grandma's house was a natural thing. We may also notice that Annie was pleased talking to all of us, including grandma, indeed maybe 'the whole (extended) family' was the 'intended callee'. Note also that the charging issue determined the user behavior (local, regional or long distance call charging). When Uncle Arne in the same town was calling, the behavior changed from 'social talking' to 'arranging a family event' (at either place).

Many homes, including my own (big) house in the 70'ties, had several phones (on one line), and 'call transfer' was an easy manual procedure, as the following case describes:

Case B) Call transfer on POTS: The call was answered by mom in the kitchen, saying 'Kristiansen's phone'. The caller may present herself with name or maybe instead just say "I want to speak to Bent, please." (Bent is a son in the family). Mom thinks she know that Bent is around the living room somewhere, so she speaks/shouts to Bent ('via air' in that direction) and ask him to

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[1] One exception is: When activating the call forwarding service (via *23*...# etc). Also when using SMS and messaging systems there is one user at the time, but still those interactions are better understood as communication between both parties and the history. (See e.g. [4])

[2] Some telecom acronyms are explained at the end of the paper.

[3] In the telecom domain a (networked) application is also called a (networked) service.

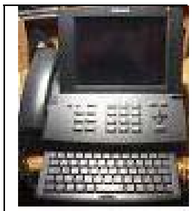
pick up the phone. She then (politely) hangs up the phone. Later she may ask Bent who the girl was (and she may/may not get an answer).

Comments: In fact with POTS you do not need to know which telephone device the other person is about to pick up (we had 3 phones). It was also possible for both mom and Bent (and more persons/phones) to talk to the caller/callee simultaneously if wanted. I was explicitly warned in 1999 (when moving) that this family friendly feature was lost in ISDN. I was strongly recommended not installing ISDN in houses with several floors, this advice was from an architect (a house architect that is). Here we may also note that if caller-ID presentation had been on the market, then mom might not have picked up the phone in the first place. However distinguishing Dina from Dina's mother Mrs. Olsen would be a 'best guess', after all each family had only one phone number.

3.2 ISDN and multiple devices (90'ties -->):

One special feature of an old fashioned POTS phone is the fact that it has neither an off-button nor a 'no-button'. (See description in [1], but see also the note here[4]). We will now illustrate the use of the no-button in the case of 2 phone devices on ISDN in a family setting.

In Time Magazine [8] in 2000 you can read about Telenor 'Smartphone': "Norway has become the first country in the world to introduce computer-free Internet access using high-speed isdn lines". We may note that it was marketed also as: "This is not a phone, This is not a phonebook, (etc.) ".



The Smartphone has a touch screen

The Smartphone uses the screen to display a (soft) no-button during the call setup phase. This is also in use for call waiting, 3-party conference calls, activating forwarding etc.

The phone also has a (standalone) address book. It can also be used for web surfing (via ISDN)

I think it is fair to say that Telenor did not have much success with this phone. My husband bought one of the phones cheaply from 'the rest supply' of a telecom related company. (Search the web for some discussion on the matters).

On our other ISDN-phone (a Hagenuk Europhone) only number (no name) is shown as caller-ID. Some ISDN phones may have a special no-button. On our Hagenuk you need to press 2 buttons to 'answer no' ([3], p.14). I have never done that, in fact I looked up the feature for this paper! (The phone is placed in a remote room, so I do not really need the no-button on this phone).

Case C) The no-button on ISDN: Both our two phones are ringing (we can hear both of them), the screens (on both phones) shows caller-ID/name. I go to the Smartphone and get the following options on the screen: "NN is calling: Answer-yes, answer-no". I deduce from the caller-ID that a family member is calling (not exactly whom, but the house). Many time these calls are not urgent (as seen from me at least), hence I do not want to answer it right now. So I press 'answer-no.' The other phone continues to ring upstairs. My son answers the phone upstairs, and he reveals the fact that I am at home (and hence 'available' according to (old) 'moral standard of answering phones' (see [1]).

Comment: This illustrates that the no-button works *per phone* (endpoint), and not *per call*. We may also note that the 'no-button' looks different on the different phones.

The Smartphone also has a call log for all calls. It can be sorted by 'in/out', 'un/answered' or by 'time'. Our Hagenuk ISDN phone has a call log for the last 9 lost incoming calls, ([3], p.26).

Case D) Call log on ISDN: When I come home from work I may check the call log for lost calls. I will do this on the closest phone, which is the Smartphone. I find a call from Frank (a friend of my son) tagged as 'lost call'. However, I have learnt that when my son answers the call upstairs, which is likely, it still shows like 'lost call' (on this other device). When I realize that my son is not home, a 'best guess' would be to assume that he is with Frank. (My son often ignores his mobile phone, or leaves without it)

Comment: Also the call log for outgoing calls shows only the calls from this particular phone. Again this shows that the implemented call log is *a pure endpoint* service on the Smartphone, and not coordinated with the phone system's (the switch's) information about the 'whole call' and the family entity ('the isdn line'). Hence even though ISDN has been planned with several phones, call transfer etc. the phone manufactures has implemented (only) an endpoint service that give as result that the views of the call log are 'inconsistent' (i.e. depending on which phone you ask).

Due to lack of space GSM cases are not included, but when the task is to 'plan to pick up a thing from a home' interesting cases (relating to e.g. mobility) may occur and be worthwhile to study or reconstruct as well.

4. Frameworks and concepts

As a starting point we will start with the existing framework P3 from by Jones et al [6]. P3 is not targeted towards multiple interfaces per user, rather for general CSCW studies. We still find it useful for our purpose. We will also describe service providers and other concepts relating to the business model, as these concepts are needed to 'understand' and explain the cases already presented. Our concepts are in *italics*.

4.1 Places

The P3 framework [6] discusses persons and geographical places. They introduce physical and virtual places. Many studies show that SMSes and phone calls often end up in a meeting in a common (physical) place (the place need not be specified). Hence, regarding places we find it useful to separate between:

[4] In fact [1] describes only the 'off-hook feature'. Note that the 'unplug feature' will work as a more normal off-button.

- A given *physical geographical place* (like 'my living room')
- A *not-yet-determined geographical place* (like 'a common place where we can meet', it may also be a public café or the family's summer cottage)

Note that this 'not-yet-determined' is different from a 'virtual' place on the network (like a place in an online game). It is a real (physical) meeting place (and it need not 'be online').

We may note that the distinction between *fixed* places (and things) and *mobile* places (and things) of course also is relevant (think again about the task to 'pick up a thing from a home')

This enhances the concept of geographic place in the P3 framework slightly. We may notice that we may also talk of yet another type of 'virtual' geographical place: 'The home' of a child living with 2 divorced parents having shared custody is one such example. In this case the famous refrigerator doors are real and physical. *Distributed (physical) place* seems a better world than virtual for this.

4.2 Persistent vs ephemeral

[6] points out that the same application may use both persistent and ephemeral mechanisms. For our discussion it is useful to separate the *media stream* ('call content') from the *call signaling.* The first is almost always ephemeral, while call signaling data is persistent in a call log on most modern phones with a display (such as ISDN/DECT).Also *network based services* such as 'call back to last lost call' may exist as well.

This persistent call signaling information will typically be accessible to 'all' persons having access to the fixed (or wireless DECT) phone (i.e. all persons having access to the house). On the mobile phones (such as GSM) we may have access control (in the form of lock key and PIN codes).

We see that also the concept of the (one) *person using* the (mobile) phone may be a useful concept. This may be different from the *subscriber*. Note also that non-users close by may hear (and see) the ringing (only in an ephemeral way).

4.3 Devices, applications and businesses

The POTS phone system is one example of *one application (service) distributed on several devices. (*Several phones in one house, and at least one in the other house, several switches etc.) The same is true for mobile system (GSM) of course (phone, voicemail server, SMS server, switches etc.). These devices are partly manufactured by different *business entities*, using their own *brands*. This branding is important for mobile phones, and some other consumer products (less for fixed ISDN phones).

Of course also the opposite may occur: We may *have several applications on one device.* This may be *planned* for from the production (GSM phone with MP3 player), or new applications may be *installed later*, e.g. by the user (a timer alarm on SonyEricsson P910 may be installed in Java). We may also buy an answering machine and hook it into our phone at the end point. This is *partly planned* for. I.e. it is planned by *one of the business entities*, and 'unknown' to the others (in this case it is unknown to the phone vendor and the telephony provider).

We have seen in Case D) that the endpoint and the network have different views of the call outcome. These inconsistent views are due to lack of synchronization. We will use the term *end point centric* application as opposed to *network centric* application. The current implementation of 'lost call log' and 'outgoing call log' is thus end point centric.

Even in GSM we may see problems with this. The 'lost call log' on GSM only shows calls that reached the mobile, not calls lost while the phone was out of coverage.

4.4 Persons, families, activities and contexts

A place like a home consist of (several) persons, roles, physical things, 'ambiance' and other social matters. Even a fixed physical geographical place like 'my parents home' has a changing context also over short periods of time. People may come and go, TV may be on or off, and dinner may be on the table to mention a few factors. My parent's house happens to be close by the railway and when a train is passing this may produce interference with radio and TV in the house. Hence we see that also changing *outdoor context* influence the *indoor context.*

We will not go into many details here regarding 'intents' and 'activities'. But we will note that the 'intent' behind a family phone call can be simple ('planning to pick up a thing', but most often it is complex and belongs to (several long or short term) activities such as: 'maintaining family relations', 'organizing practical issues' (making food, transportation, ...) and more.

The 'called user' need not be a single person, but it may be a role (like a parent) or a whole family (See Case A). So we may add *role* and *subgroup* to the person concept, but we may note that in many cases the 'group' will be informal, thus a formal modeling of 'group members' might not help us. The concept of *informal group* may however help when discussing our design.

5. Implications for design

We will discuss some general implications for design, and after that close the paper with a concrete new service and some discussion on that.

5.1 What is a 'family phone call'?

We believe that it is important to understand that calling a 'family phone' (or a physical doorbell for that matter) is not 'calling one person' (and not 'calling 4 persons' either). Rather it is a subtle combination of calling a family and calling a place. And that this is not always easy to integrate with mobile phones which are personal (and where location is 'hidden' and not so predictable).

The history of the communication is also important, see e.g. Case A) and [4]. This history may be across many applications on several devices, as well as non-technical artifacts. Oral (face to face) communication, yellow notes, fridge doors, emails may be involved and several persons may be involved as well.

A phone system is traditionally made to be very general. Normally there is no way to signal your 'task' or 'activity' in a phone call. We may notice that ISDN has (a little used) feature of sending a short message with the call setup as unstructured text.

Quite often *several tasks* (or 'intents') shall be handled, and they are not formalized. One example is: discussing the next transport to a family dinner with my oldest relative, as well as talking to her about her current wellbeing.

It will not be easy to formalize (or even express) these diverse 'intents' or 'tasks' into the call setup procedure. Hence 'task related signaling' may not be any good idea, (not even as unstructured text).

5.2 TeliaSonera 'HomeFree' service

This service makes use of the new UMA technology. The most important UMA feature is that calls from your mobile will use Wi-Fi and fixed broadband and IP-technology from your home. These calls will have a free minute charge in most cases. (Hence the name of the service includes 'free'). A monthly fee applies, though.

'HomeFree' also offers to combine up to 5 mobile phones and one fixed phone number in a 'family concept'. Calls between these phones are cheap/free, and calls to the fixed phone number may be forwarded to mobile(s) when no one is at home.

We will describe how 'HomeFree' handles a family call when no one is at home. As already stated a 'family call' is a subtle combination of family, persons, context, activities, and/or physical place and things. The current version was to call all mobiles in parallel (according to oral communication presented at Kursdagene, ntnu, Jan. 2007). In that case we may ask the following questions:

1. Shall the call be shown as a 'lost call' on the other mobiles?
2. Or shall instead the call be forwarded to one mobile of grandma's choice (via voice menu, (press 1 for mom,..) ?
3. Or should the call be forwarded in sequence? And in case: In which sequence?

In case the answer is 'no' to question 1, we may note that there is a need to re-implement the 'call log' functionality in a not endpoint centric way. Take specifically the comments after Case C) and Case D) into account since they already deal with multiple terminals and multiple users. Such a reimplementation will allow the family to view the total outcome of the call, not just what happened to the call on this one device. But this require combined efforts between several business units (several mobile phone vendors and the service providers), and this is less likely to happen, even though it may be upgraded via software only.

If instead option 3 is selected, then we have the same problem. Option 2 seems better from the 'multiple family device' point of view, but maybe not the best for the caller. She might instead hang up and choose for herself to initiate a new call (to a specific mobile / person) this time, thus bypassing the whole new familiy forwarding service. (In this case location information may be of relevance, presented to grandma to support this decision, but there are several aspects of this feature as well, not to be discussed here)

In case of showing grandma's so-called 'lost call' on all mobiles, this may annoy the users in the long run. It may also result in no-one calling back if the call is *really lost* (on all mobiles), since everybody may assume someone else have handled the call already.

6. Conclusion

We have found it useful to study several concepts relating to 'one-many' issues when discussing multiple and ubiquitous interactions. We separate between multiple users and multiple devices. We have also identified some cases where multiple manufacturers (and/or service providers) are involved with different business interests. This contributes severely to the problems of making 'ubiquitous interactions'.

We have applied the concepts when discussing new services launched for 'family-communicaton', such as the new service 'TeliaSonera HomeFree'.

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Abbreviations

DECT: Digital Europ. Cordless Tele. (wireless phone in home)
GSM: Global System for Mobility
(i.e. 2nd generation mobile system (as used in e.g. Europe)
ISDN: Integrated Services Digital Network (digital fixed lines)
POTS: Plain Old Telephony System (analogue, for fixed phones)
UMA: Unlicenced Mobile Access (via e.g. Wi-Fi)
Wi-Fi: Same as WLAN (wireless LAN), unlicensed frequency

SpaceExplorer – A Ubiquitous Web Browser Extension for Spatial Web pages on Multiple Devices

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ABSTRACT

Web pages are designed to be displayed on a single screen, but as more and more screens are being introduced in our surroundings a burning question becomes how to design, interact, and display web pages on multiple devices and displays.

In this paper I present the SpaceExplorer prototype, which is able to display standard HTML web pages on multiple displays with only a minor modification to the language. Based on the prototype a number of different examples are presented and discussed and some preliminary findings are presented.

Author Keywords

Ubiquitous Web, Multi-user interaction, Pervasive interaction, Multi-display web pages.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

With more than 13 billion web pages on the internet the amount of information available from any web browser is huge. However, while these web pages might be viewed on different devices with different displays they are all designed for only one display. But with the increasing number of devices able to access the internet (PCs, setup boxes, PDAs, mobile phones, game consoles and many more), the question of how to design web pages that facilitate a multi-display and device setup becomes highly interesting. Little research has addressed the issue, though the topic has received some interest recently labeled the Ubiquitous Web [8]. The research branded with this label is though preliminary and does not yet demonstrate working implemented systems.

If web pages are to be extended to multiple displays a number of challenges exist. First, technical components need to be designed which is able to handle the local communication between the displays. Second, the HTML needs to be extended or twisted to be able to express how web pages should react to a spatial setting with multiple displays. Third, web pages need to use new metaphors for building content for multiple displays.

In this paper I present the SpaceExplorer, an extended browser which addresses the mentioned challenges. A wrapper around an Internet Explorer handles the local communication between the displays. The prototype uses the “target” part of the <A> link tag to describe how the page should be displayed on multiple displays without introducing new elements to HTML. Finally, has a number of web pages been designed which uses this setup.

THE SPACEEXPLORER PROTOTYPE

The SpaceExplorer prototype is designed to explore how web pages can facilitate multiple devices. Such a configuration could be a TV, a laptop, a projector, an interactive picture frame and a mobile phone. Another setup could be one projector and multiple laptops. Such multi-device setup is becoming increasingly more common in homes, offices, and public spaces.

The technology

The system is initially implemented as a small C# program with an embedded Internet Explorer. While the same system also can be designed as a plug-in to some of the major browsers or a proxy server running on the local computer, the embedded approach proved to be a fast way to get full control of the displayed web page for prototyping purposes.

The system is implemented as a client-server system in the current version. One of the devices is started as a server and the rest of the displays connect to this server. While a peer-to-peer solution or a solution based on service discovery might be more flexible, for prototyping purposes the client server-solution worked well.

A typical use scenario is the following. The browser is stated on a device and the device is setup to be the server. The other devices connect to the server's address in client mode with the name identifying the role of their device. It could be "TV", "projector", "left screen", "right screen" or something else. At the moment no fixed taxonomy of devices exists and it is probably also better to let the taxonomy be flexible with XML like namespaces instead of defining a fixed taxonomy of devices. Figure 1 shows a screenshot of the prototype.

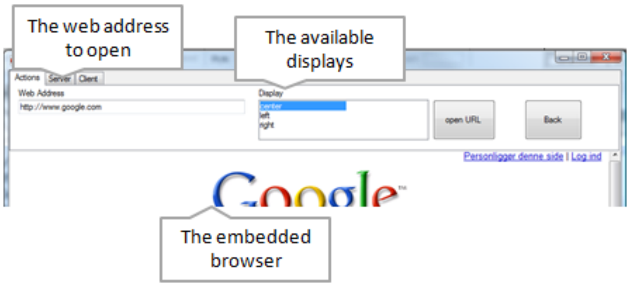

Figure 1: The SpaceExplorer Prototype. Above the embedded browser is a status bar for connecting, opening pages and selecting and viewing remote displays

Four approaches exist for displaying content on different displays.

1. When a page is loaded the SpaceExplorer browser analysis the web page and part of the refereed content is opened in the Browser on some of the other displays.
2. If a hyperlink is augmented with a specific mark this link is opened in the browser on another display.
3. If a specific key is pressed (e.g. Control) while clicking a link a dialog is presented to the user where the user can select where to open this link.
4. The user can type in a URL in the control bar and select the display, which should open the page.

These four approaches present the designer and user of web pages with some powerful new tools for creating and browsing content on multiple displays.

Augmenting the HTML

The main design criteria for augmenting the HTML is to make the change as non-invasive as possible. By augmenting the target property of the <A>-tag in HTML with a specific semantic the browser is able to support the above described behavior while making the web page fully functional in normal browsers as well. The two special characters that are introduced are the "@" sign for opening a link on a new display when the page is loaded and the "#" for opening a link on a new display when the link is clicked.

```
<a href="newpage.html" target="@left#right#tv"/>
```

For instance the above piece of HTML will when the page is loaded try to open the newpage.html on a new display. The page will first be opened on the left display if a left display is present. If not it will be opened on the right display, and if this display is not present neither, the TV will be the third display tried. For opening a link on a new display when it is clicked the "#" sign is used as demonstrated below.

```
<a href="newpage2.html"
target ="#pictureframe1#pictureframe2#choose"/>
<img src="mypic.jpg"/>
<a/>
```

This piece of HTML will display a picture. If the user clicks the picture the picture will be send to the display called "pictureframe1". If this display is not present "pictureframe2" will be tried.

"Choose" is a special keyword that will present the user for a dialog box in which the user can chose between the different displays present.

USING THE WEB ON MULTIPLE SPATIAL DISPLAYS

While the extension seems to be small, moving web pages into a spatial setup opens up for a group of new applications. Below will a list of scenarios be presented and discussed that take advantage of spatial browsing on multiple displays.

Enriching web pages with multiple displays

With single-display design the focus of the user is often on the display. With multi-display design the other displays can to a larger extend be used to present more peripheral information.

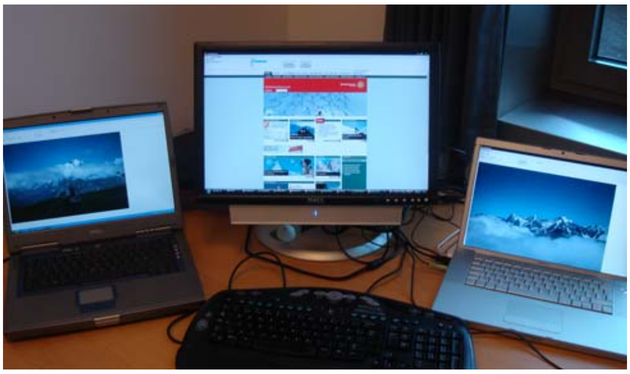

Figure 2: A setup with three displays. The middle display shows a travel agency page and the left and right display show pictures and videos from the selected area in Switzerland.

For instance, a travelling agency can chose to display a slide show of images from the location the user is searching for on or additional information on the selected topic on one of the peripheral displays. This scenario is illustrated above in Figure 2.

Content for the right device

Another use of a multi-display setup is to present the web content on the device best suited for that particular information. For instance, when browsing for a theatre movie the trailer to the movie can be showed on the TV display which will often have better sound and picture. The computer display can then present in-depth information about the movie and availability. Other examples could be contact information to a company's support department being showed at the mobile phone display or snap short from an auction house being showed in a large picture frame on the wall.

Collaborative interaction

The two first scenarios focus on the setup with one user with multiple displays. However, the technology also opens up for new possibilities in shared settings with multiple users and displays where these users can display different information on shared displays.

For instance, at a typical presentation a single person will connect a laptop to a projector and show a presentation. In this scenario it is only the presenter who can show information. With a multi-display setup, the different participants' laptop can be connected to the shared projector. This setup allows the presenter to e.g. push information to the participants' screens. In a similar fashion all the participants will be able to open web pages on the shared display allowing a much more collaborative experience.

Complex multi-user interaction

A final example resembles the Parc Pads scenario from Xerox Parc [6]. In the Pad scenario interactive paper-sized devices are available all around the office. These devices can be picked up, used and put down after use for interaction purposes.

With prices dropping on displays and computer technology this scenario is actually within reach and highly useable in a number of cases. One example case could be to coordinate the work in coordinating centers. In e.g. the acute medical coordinating central at hospitals they coordinate available limited medical resources in situations with major incidents. In these situations it is important to be able to maintain an overview and awareness of the situations. Information such as how many patients are wounded, how many resources are available and where these resources are, pictures, videos, maps and similar information is critical.

Instead of collection this overview on one large display, with the above presented technology this information can be distributed to a number of displays and information can easily be moved from a large display to e.g. a mobile display or from a mobile display to a shared display. A user can e.g. click on one or two video feed on a shared display and move these feeds to a new display. These displays can then be moved around, placed on a desktop or hanged on a wall together with other relevant video feeds collected to support the task at hand.

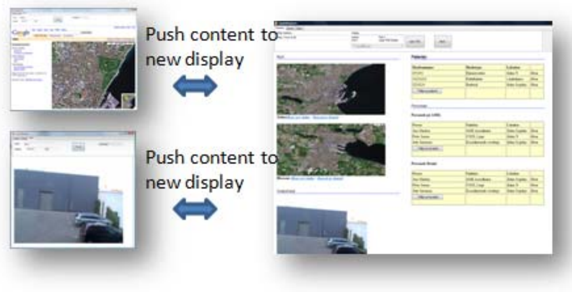

Figure 3: This figure shows how information can be exchanged between different displays in an overview situation.

Figure 3 shows an example of how e.g. an overview web page with maps, video streams and patient information can be moved to new displays.

RELATED WORK

The area of developing web technology for multiple devices and displays falls into the area between hypermedia and web technology and ubiquitous and pervasive computing.

From the hypermedia perspective a number of research approaches have worked with bringing properties of the physical world into the hypermedia world. Within spatial hypermedia the spatial aspects of data and their relation to the physical world has been investigated [1]. Context-Aware Hypermedia focuses on how the context web pages is being used and created in can be modeled [3]. A large number of projects also address how to be able to present hypermedia information on a wide variety of displays with different sizes and capabilities. Some of the earliest research within this area is the Dexter Reference Model and the introduction of presentation specifications [2].

From a pervasive and ubiquitous computing perspective similar initiatives work on being able to seemingly connect multiple devices and displays. The Palcom project works on an open architecture for how to connect multiple devices in an easy and understandable manner [9]. Standards such as UPnP [11] and Sun's Jini [10] enable multiple devices to be easily coupled together. In [4] Pervasive Mashups is presented as an approach to building system by combining a variety of applications with the physical setting. Finally, has a number of projects work on moving the web onto pervasive devices e.g. Web Services for UbiComp[5] and Nokia Apache Server for mobile phones [7].

However, while a large number of projects work within this area, none of the projects have directly addressed how to design web pages for multiple displays.

CONCLUSION AND FUTURE WORK

Being able to display web pages on multiple displays opens up for a number of new interesting possibilities for the design of web pages. Web pages that are divided into information provided at the primary display and information presented in the periphery on other displays. Experiments with the technology have also showed that the basic technology can also be used to support a number of multi-user scenarios. The ideas and results presented in this paper are the early findings of using this type of technology. Further investigation of the use and design of web pages with this technology will hopefully be able to further inform the design.

The SpaceExplorer prototype is still under development and some of the interesting future extension will be to support cross-display scripting, specify a mechanism for service discovery, and port the system to other devices e.g. mobile phones.

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Mediating Inter-Personal Communication in Ubiquitous Computing Environments

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ABSTRACT
Ubiquitous computing will add a new dimension to communication between people. In a ubiquious environment, interpersonal communication can be mediated by virtual agents. Access to services can be automated so the user does not need a human attendant. Such an environment will be useful for those, besides regular people, who feel it uncomfortable to directly negotiate with other people in the real world. This paper discusses how a uniquitous environment can serve to reduce problems that hikikomori, or acute social withdrawal, persons encounter in the real world.

Author Keywords
Hikikomori, ubiquitous computing, experience, communication

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
A social phenomenon called "Hikikomori" [1] is gaining much attention lately in Japan and other Asian Countries. Hikikomori, or acute social withdrawal, refers to the situation that a person, typically a young male adult, stay in the room for months or years.

They find it difficult to talk to people directly and prefer to communicate online. In fact, they do not have to talk to people to accomplish their needs. They can purchase almost any products on the Web. In the virtual world, money circulates like the real world, a community is formed, and society exists. Moreover, they can communicate by participating in social networks. Even if they do not make a friend in the real world, they are not isolated. If they loose a social link with a virtual world due to poor communication skills, they leave the community and move over to another community in the virtual world.

The network game is making the situation worse. Some games are designed such that the players feel guilty if they want to leave an ongoing game. If they do not want to be isolated in a gaming world, he is compulsorily restrained in the game for many hours. Thus, many hikikomori persons are forced to commit to the game over a long period of time.

Once a persons becomes an acute social withdrawal, it requires great effort to recover from it. They become less fluent in person-to-person communication and ultimately chose to live completely isolated from the society in the real world. Discrimination of hikikomori persons makes the situation even harder.

Hikikomori persons prefer to communicate, play games, and perform jobs within the room and try to avoid going out. This situation has been strengthened by the tendency that computer applications and services provided through them are centralized around desktop PCs. In the generation of ubiquitous computing, we may be able to change the situation by associating communication activities to actions in the physical world.

The goal of this study is to encourage hikikomori persons to direct to the physical world. We aim at providing people in acute social withdrawal a new way of life in the ubiquitous environment, by reducing the burden of directly negotiating with other people. Ubiquitous computing environment serves as a a means to mediate the communication between an acute social withdrawal and people in the real world. With the computational support in communication, they feel less fear to go out of the room, and merge in the society easily.

AN ADVENTURE SCENARIO OF HIKIKOMORI PERSONS
To illustrate a possible use of ubiquitous computing for reducing communication burden, we sketch a scenario of a venture of hikikomori persons.

On a holiday, in the near future, in some city, Akira, Bizen and Caoru got together at the station square and went to the library to look for books for their course assignment. They wore an earphone and a microphone on the ear. They also wore a monocular head mounted display and a camera in front of the eye. Those devices were connected to the personal digital assistant. Although they did not have decided where to meet up specifically before going out, they could find each other easily thanks to the super-imposed image fed from the GPS navigator. Caoru, however, seems to have overslept and did not show up. Caoru popped up on the display of Akira and Bizen and said Ï still on the train and will catch up with you soon.SSo, Akira and Bizen decided to got for shopping individually until Caoru arrives. Akira went to a computer shop, and Bizen went to buy some clothes. Although they split, each other's figure could be seen on the display as if three of them were altogether. They were talking while they move to the computer shop and the boutique. Akira wanted to buy some computer memory in the shop. At the computer parts section, a CG figure of a salesclerk showed up on his display and gave him some suggestions. Because Akira wanted to choose by oneself, he turned off the salesclerk's picture. Instead Akira shared his vision with Caoru, who knew about computer well. Akira also wanted to know how people say about the product on the Internet. By looking at the product tag, Akira searched for the product evaluation in the bulletin boards on the Internet. Akira turned on the picture of the salesclerk again and told that he wanted to buy the item. The clerk received Akira's home address and a coupon Akira could use. All transaction was automatically done on the Web, and the item was scheduled to be delivered to Akira's home later.

Meanwhile, Bizen could not find clothes in the boutique. Bizen shared his sight with Akira walking in the town and Caoru riding the train. Bizen asked Akira for suggestion. Akira had seen a person in the town whose clothes might fit on Bizen well. PDA automatically identified the moment that the camera had recorded based on the features including black clothes, before least, and vicinity of the intersection. Bizen looked at the picture Akira forwarded to him and liked it, unfortunately he learned that clothes were sold out in the shop.

When Bizen finished shopping, their displays indicated that Caoru's train was arriving in five minutes. They decided to meet in the open space the station square. Caoru was in such a hurry that he did not watch the traffic light. At that moment, an electric shock was set off to his feet from the collision prevention device in the shoes. Caoru recognized the danger and stopped instantly, a warning of a red light was shown on his display, and an alarm was heard from the earphone. In the next moment, a car passed right in front of Caoru. He realized that he narrowly escaped from an accident. He felt that this experience was sensational and wanted to show it in video to Akira and Bizen. A fairy-like agent in Caoru's PDA navigated him through the process of video editing and posting on the Web. Meanwhile, Caoru talked to Akira and Bizen about the experience as he walked.

After they met, they decided to go to the library. But none of them knew how to get there. When Caoru told the fairy that he wanted to go to the library, the fairy told him the time for the next bus. On the bus a blank signboard came in their view. Akira saw an advertisement of the computer shop, and Bizen saw an advertisement of clothes. Because Caoru was not interested in seeing advertisement, he turned off the super-imposed information and saw a blank board. They got off the bus at the library. Caoru could see a path to the library on his display overlapped on the real world.

The fairy in Caoru's PDA served as a librarian. The fairy explained how to use the library and gave them information about new books by the same author of the book Caoru purchased earlier on the Web. Each of the three went to look for a necessary books for their assignment while hearing fairy's navigation. They shared information of books via the sight and active tags. Although some books were not on the shelf, they were replaced with electronic versions. Caoru chose a book in a foreign language that he did not know any word. But the words were automatically translated for him to read. Several hours later, they borrowed some books in either electronic or paper media.

Information of restaurants nearby was displayed on their display when they left the library. Because Caoru chose to display gourmet information in detail, some restaurants with good reputation and coupons were shown on his display. And they disappeared to somewhere in the town.

TECHNOLOGICAL ISSUES

communicating real world experiences

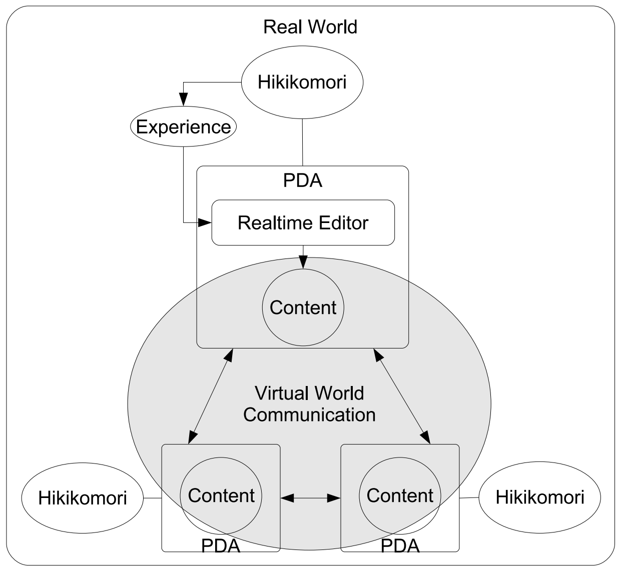

Figure 1. Communication for hikikomori persons in ubiquitous computing environment.

There are two key issues in the scenario above. One of them is to capture experience issues in the real world in a digital format and share the experiences. As we illustrate in the venturing scenario, people constantly encounter new situations in the physical world. Communicating about such events as experiencing a sensational moment makes a hikikomori person care about the real world. Thus, ubiquitous network can encourage hikikomori person to communicate with their friends about the events and experiences in the real world. In other words, ubiquitous communication brings their virtual world close to the real world.

The advantage of communication in a ubiquitous environment is that it is not restricted by time and place. Gathering information and transferring it can occur nearby. In other words, live information is fed to the network across ubiquitous environments. A system that enables editing and transmitting information easily and rapidly will be useful in such a ubiquitous environment.

Data about the location are useful in a ubiquitous environment to organize information. In ubiquitous environment, selecting information according to the context is most important. The system needs to manage multiple information sources from mobile devices, such as GPS and RFID. For example, if one is crossing the road, status of the traffic light needs to be displayed. If one is looking at a product in the store, information about the product and needs its reputation to be presented. To present appropriate information, the system needs a mechanism to retrieve data using context-dependent data.

Mediating inter-personal communication

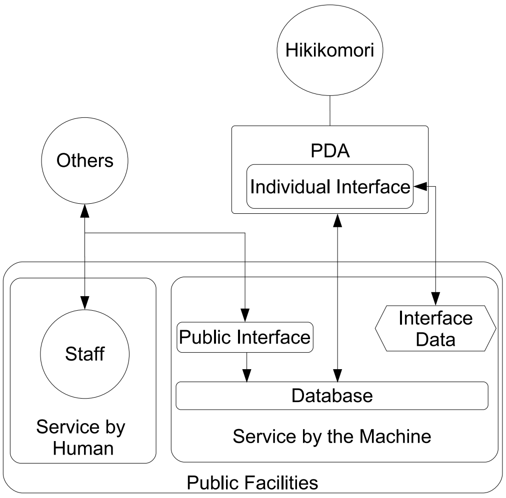

Figure 2. A personalized interface for hikikomori persons in ubiquitous computing environment.

The other key is that a person carries a personalized user interface. For a hikikomori person who is afraid of talking to a new person, services are preferred to be provided via automated system rather than a human. He feels comfortable to shop online, because the computer processes all transactions automatically and does not see any person behind it. If we extend it to a ubiquitous environment, a computer-generated agent is preferred over a human clerk. Since this is close to an actual communication compared with online, it may serve as a bridge for him to join again to the society.

In venturing to the real world, it may discourage a hikikomori person to straggle with confusing user interface. It may be a source of anxiety for them to expose to the public their lack of knowledge how to use those machines. It may even leads to an embarrassing situation if they are in the middle of annoyed people who wait for the machine behind him. An alternative approach to avoid such an embarrassing situation is to provide a personalized user interface. As depicted in Figure 2, a user interface of a database-driven system can mediate the communication. It shows up in PDA of the hikikomori person and encourages them to accomplish the task, rather than making them feel uncomfortable with others. In addition, the personalized user interface can keep record of the transaction and navigates the user in the next time.

COMMUNICATION TOOLS IN UBIQUITOUS ENVIRONMENT

To address the technological issues in the previous chapter, we are developing for the ubiquitous computing environment. These tools are meant to assist hikikomori persons feel easier in venturing to the real world.

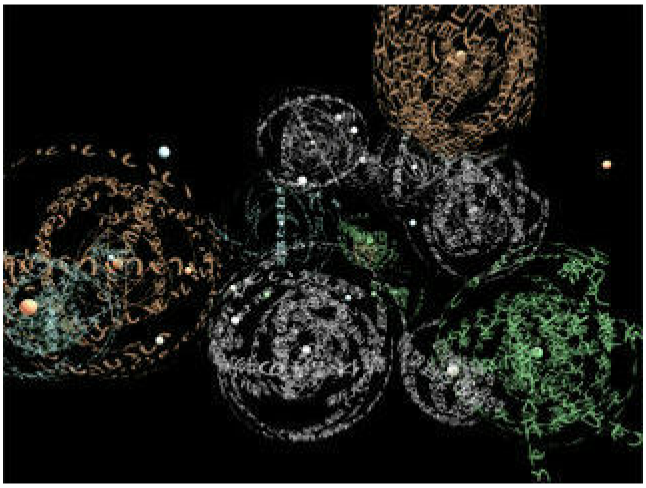

Figure 3. Kotodama

Kotodama is a communication support tool for hikikomori persons on a mobile phone. This interface retrieves information from various databases and displays it. Each sphere represents digital data created by people in the community. The data is associated with information about the location. The data in the sphere will be created by using a device that we call Ambient Memo shown in Fig. 4.

It associates communication data with information about the location. The user of Kotodama and Ambient Memo will be able to information and the location in the physical world.

Kotodama and accommodate digital data such as picture and video. Another tool that we call Mobile-Sai [3] allows the user to capture events with the camera and add various effects to the picture and video. The result will be stored in Kotodama along with information about the location.

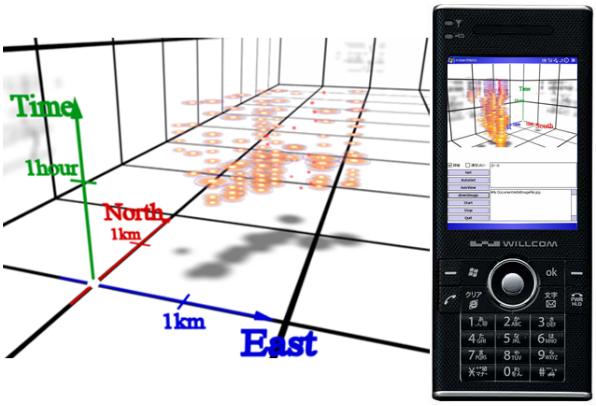

Figure 4. Ambient Memo

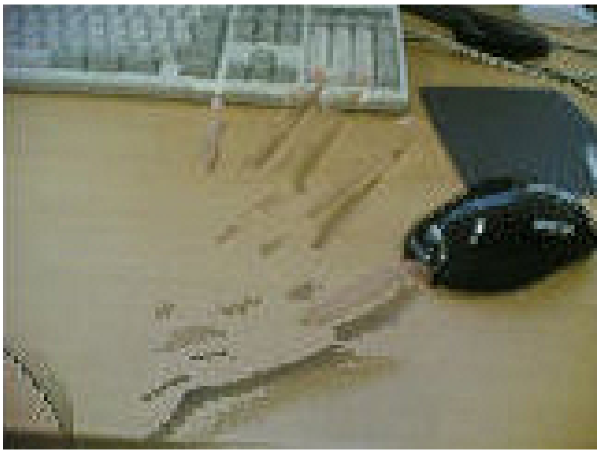

Figure 5. Mobile-Sai

RELATED WORK

Bødker [2] discusses that currently research in HCI is moving from the second wave to third wave. She points out that in the third wave, ubiquitous computing changes how we work and live. The focus of research moves away from PC-centered view to distributed computing environments.

Multiplicity

Multiplicity is essential in ubiquitous computing, in which the user wants to combine multiple displays and input devices to create his or her own computing environment. In tackling the technological issues discussed above, we need to develop a framework to integrate multiple devices to support communication of acute social withdrawal people. It calls for a flexible structure of the framework such that multiple mediators and information sources can be incorporated in user's ubiquitous environment.

Context

In the scenario we presented above, signboards in the town changes responding to the viewer's interest. The viewer's interest is part of the context with which devices determine what to display and how to interpret input from the user. In order to implement such use of context, we need to trace the activities of the user, and analyse them to capture the interest of the user.

Experience and reflexivity

Sharing one's experience with others gives an opportunity to reflect on his or her life. To make such information sharing possible in a ubiquitous environment, we want to provide means to create lifelogs.

Participation

Bødker points out that participatory design remains an important means of finding design requirements in third wave of HCI. This is particularly true in such situation that the user wants to connect his or her interface device with other devices and data sources in the ubiquitous environment. Design problems of incompatibility of devices and data in such an environment can be immediately recognized. We belive that user participation is critical in the development of the framework proposed in this paper.

CONCLUSIONS AND FUTURE WORK

Ubiquitous computing will change communication in a fundamental way. It opens up possibility of moving in the physical world while being connected with others. It also serves as a means of reducing the hardship of hikikomori. Unlike the current situation that they withdraw in their own room, ubiquitous environment can extend the space to outside their rooms. For this reason, we assume that ubiquitous computing is most needed by hikikomori persons. Of course, the technologies developed for them will be useful for regular people. Ultimately, ubiquitous computing will serve as a device to assist people to overcome communication barriers in the same way that assistive technology does for handicapped people to overcome physical barriers.

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