Designing for Usable Disappearance – Mediating Coherence, Scope, and Orientation

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ABSTRACT
In this paper, I emphazise on the users' experience when faced to disappearing user interfaces. I will start out, confronting potential conveniences of ubiquitous computing and related visions to possible shortcomings in their implementation due to design flaws. Three key issues for user-centered design of disappearing interfaces in ubiquitous computing are proposed, namely perceived *coherence* of computerized devices, awareness of the *scope of effects* resulting from one's interactions and support for *orientation.* I will illustrate these issues by use of examples, arguing that intuitively regognizing the potentials of a designed network of computational artifacts will be crucial for the users' acceptance of UbiCom environments. Therefore, I will promote the careful design of human-perceived context, which uses familiar symbols and affordances to make user interfaces and options visible. I briefly refer to components of the 'product language' before presenting selected features of roomware environments and pointing to future research.

Keywords
ubiquitous computing, coherent experience, human-perceived context, U^2I design, computational artifacts, calm technoloy, convenience

INTRODUCTION
The vision of *ubiquitous computing* (UbiCom) promotes that our everyday environment will be interwoven with and augmented by a multitude of interconnected *computational artifacts.* The ultimate goal is to make "everything faster and easier to do (...) because ease of use makes an enormous difference" [20]. Information technology (IT) will therefore disappear into the background (as electric motors did), where *disappearance* denotes true invisibility, transparency, or subordination by other aspects [4] as it has become true for electric motors ("UbiMot"): First, they are often truly invisible, e.g., in cars. Second, there are transparent tools based on electric motors. Third, we take their functional aspects for granted, but it still matters how the so-enhanced objects and their UI do look like.

The envisioned progress of technology towards UbiCom will introduce more *calm* into human-computer interaction (HCI) through "engaging both the center and the periphery of our attention, and in fact moving back and forth between the two" [21]. UbiCom technology is supposed to support us in the fulfilment of our everyday tasks, being less disturbing and introducing ease, e.g., by empowering the networked devices, but also necessitates introducing a more conscious user interface design (UI design) in a broader sense.

UI design for UbiCom (U^2I design) requires the design of hybrid artifacts and environments for a coherent and engaging experience. In designing *Roomware®* for *Cooperative Buildings* this has been approached by an integrated design of real, physical, resp. architectural spaces and virtual, resp. digital information spaces [16].

One approach to reducing the complexity of *explicit interaction* with computers is to complement it with *implicit interaction* based on perception and interpretation of data provided by, e.g., sensor-equipped devices [12]. By perceiving the *situational context* (context for short), so called *context enabled applications* become feasible. They facilitate not only implicit interaction but also the adaption of input needs and output properties to the current situation. Relating to this, it has been discussed how the *affordances* of physical tokens (e.g. *WebStickers* [8] and in a more general sense *Passengers* [6]) and the context they are placed and/or used in, can act as useful cues for users. A framework, namely the *Context Toolkit* [11], has been introduced to capture helpful abstractions and to provide generic services aiming at facilitating the development and deployment of context-enabled applications.

POTENTIAL CONVENIENCES FOR INFORMATION WORK
Today's office work is determined to a large degree by information processing work (*information work* for short). In relation to a current task, information is searched, gathered, externalized, structured, evaluated, circulated, and (possibly) archived.

Vision
UbiCom promises augmented environments which facilitate interaction (with information and people) "everywhere", realized by a layer of IT-based services supposed to enrich the place.

Work processes will be better supported and more fluent because of less media breaks, less interrupts and more calm. Various work situations are supported, e.g., not only planned but also spontaneous, opportunistic and intended communication and cooperation of people (supported by a combination of mobile and in-place devices). The gathering of groups and their division into subgroups and further into individuals working in parallel will be facilitated, e.g., by intuitively aggregating and subdividing used and created information.

All of this has potential to contribute to the users' *convenience*, empowering them, to be more productive, especially in terms of information work. At the same time, users must be able to realize a sense of control and their experience should be coherently structured and engaging.

User Experience

Humans, when faced with situations they feel are too complex, uncontrollable, and unpredictable are likely to feel mistrust, discomfort, and inconvenience [1]. This can lead to less productivity if the situation doesn't change over time. Therefore, designing for coherent and engaging experiences (where the second is influenced by the first) is a central issue, if we want UbiCom environments to become a success.

Regarding U^2I design, there are at least three central issues:

1. Perceived *coherence* of components that users interact with.
2. Knowledge about the *scope* of effects resulting from the users' interactions.
3. The users' *orientation*[1].

These issues are crucial in addition to the subject matter of the respective work situation and therefore, U^2I designers must be careful not to overinform the user/s in this respect. But a certain amount of *meta-information* characterized by the three issues contributes to effectiveness, and also to quality of life (in terms of "Behaglichkeit", feeling at ease, social convenience, and comfort). This will be illustrated by the following example.

Example

Assume a well cultivated English garden with large areas of green. One morning, the responsible gardener sees himself confronted with a large quantity of molehills.

He only has a vague idea how the underground network indicated by the hills does look like, but at least he knows that the disaster was caused by one sort of animal due to the equal appearance of the hills.

The gardener is not aware of how many moles did attack his garden during the night nor does he know about their exact locations. Because digging wholes to locate the beasts is not an option, he only gets a somewhat deffered feedback about the effects of his various trials to kill them (e.g., through drowning).

Let's assume that our gardener is not very experienced in fighting moles. So he sees himself opposed to the disaster but his means of analysing the situation are not very promising nor has he a clue of how to get rid of (how to interact with) his truly invisible enemies. In addition, there is a great deal of varying dynamics in molehill construction he cannot predict. Therefore, he probably experiences a certain feeling of dismight.

Afterword: Molehills by themselves are frightening only to unexperienced gardeners (the people involved interacting with the molehill environment). How happy our gardener would be, if the hills (devices) would give him some hints where to find the moles and what the size of the team he is interacting with is. In addition, it would be nice, if the hills indicate how they are connected to each other. What if the gardener knew in advance about the effects of his in principle well directed actions (he has quite a good imagination of whom he is addressing)?

(→ remark: I will find or create an illustration of the described situation.)

COHERENCE, SCOPE, ORIENTATION

Coherence means contiguity ('there are defined relations'). Coherent *'display'*, both visual and auditory, of a body of information is known to facilitate comprehension and perception in an adequate way. Coherence is an important design goal for creating comprehensible *hypertext documents* [18] where local (node level) and global (net level) coherence are distinguished. Coherence is also emphasized with respect to *metaphors* we use to partially structure one experience in terms of another [7]. The coherent structuring of experience as well as coherence within and across metaphors are crucial for useful metaphors.

Today, most of us know, when encountering computers (molehills), identified by some typical visible attributes, in a modern office building, that there is or should be some kind of coherence among them. But most users have a better feeling for the scope of their office and the building (and corresponding access rights) than for the networks they (and others) have access to. Moreover, orientation within buildings is often better afforded than in networks.

Directed exchange of information is normally realized by using e-mail. This medium facilitates exact definition of the range resp. scope of the message's receiver/s (except intransparent aliases). But directed data exchange, in the literal sense, from one device to another, or even to some

[1] Users' orientation is typically characterized by the following questions: 'Of what situation am I a part of?', 'What is the current state of the situation?', and 'What are my options?'

defined set of others, is generally not well supported. Additionally, access to invisible network drives residing on invisible servers poses discomfort and unconvenience to a still large group of people. Even though there is coherence its potential is not well communicated to the users.

A more dynamic aspect of coherence is invisible (programed resp. configured) *automatism* of interconnected artifacts [10]. While we would have to *consciously* as well as *unconsciously* interact with several kinds of computational artifacts in envisioned UbiCom environments, it is a common experience that even simple, not at all distributed automatisms (like in some word processors) may cause users to get upset, and thereby squandering their energy.

Instead, effective interaction with UbiCom environments requires trust and confidence in the provided mechanisms and designed interactions. This will be supported through focussing on coherence, scope and orientation (see above), while also considering means of establishing trust in relationships [15] and classical means of UI design as transparence and predictability [14, 19].

Summarizing, intuitively recognizing the potentials of a designed network of computational artifacts resp. information appliances will be crucial for the users' acceptance of UbiCom environments in the future workplace.

Integrated Design

U^2I design benefits from expertise of the following disciplines: Architecture, office environment and product design, HCI, and computer supported cooperative work (CSCW). Considering that UbiCom environments with disappeared computers are technically very complex, U^2I design must strive for simplification and reduction wherever possible. Fragmented user experience and unnecessary complexity irritating perception have to be probibited. Design should exploit the context to be as concise as possible [2]. Therefore an integrated design approach is proposed as in [16].

The usablility of UbiCom environments would benefit from an integrated design striving to make 'each' UbiCom environment a 'coherent whole' with a defined (default) scope and providing cues for the users' orientation. This way, *meta-information* can be indicated by a trans-disciplinary though *consistent* design vocabulary of architecture, office environment and product design as well as screen design (interaction and information design). This meta-information determines a substantial part the human-perceived situational context, which can help users to interpret information representing the subject matter, even if processed using distributed in- and output.

Summarizing, there is potential to exploit the human-perceived situational context to make UbiCom environments intuitively usable. This contextual information should be expressed using vocabulary from several disciplines using familiar symbols and affordances that point to the possible usages of computational artifacts residing in the place.

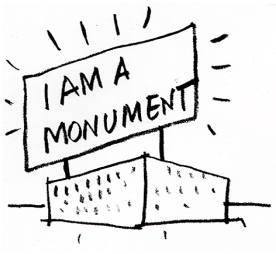

Figure 1 "How to build a monument", polemics by architect Robert Venturi, 1966

MAKING USER INTERFACES VISIBLE

In mediating (implicit and explicit) information about a product resp. artifact, we can learn from product designers. I roughly present here what is called 'product language' [3], where 'Anzeichen' is similar in meening to the notion of affordance due to Gibson.

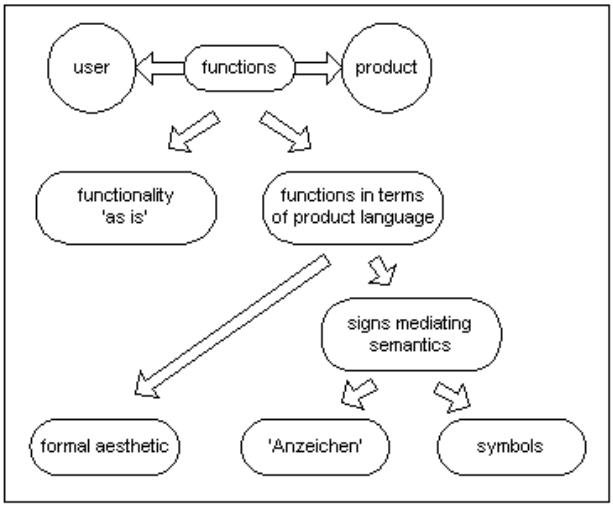

Figure 2 Schematic representation of components of the 'Product Language'

(→ I could further elaborate on this during the workshop.)

ROOMWARE

By roomware[2] we mean computer-augmented room elements like doors, walls, furniture with integrated information and communication technology [16]. This is part of our approach that the "world around us" is the interface to information and for communication and cooperation between people.

[2] The terms Roomware®, DynaWall®, CommChair®, and InteracTable® are registered trademarks of GMD and the term ConnecTable® is a registered trademark of Wilkhahn.

Figure 3 Roomware (2nd generation), Design: GMD-IPSI, Wiege, Wilkhahn

Currently, we have realized four different components (see Figure 3): DynaWall, CommChair, ConnecTable, and InteracTable. They all resemble to components which have been present in office environments for a long time. Thereby, they tie up to what we already know about the usage of the reffered to original components being partly self explaining.

They go beyond what we already know from the original components in the fact that digital information structures are accessible via touch-sensitive interaction areas and can be processed individually or in parallel. This is realized through the BEACH-Software [17]. In the following, I will not give a complete description of BEACH, but only highlight selected features.

U²I of Roomware

BEACH ("Basic Environment for Active Collaboration with Hypermedia") is a synchronous groupware tailored to support face-to-face group work with roomware components. BEACH supports scribbling and gesture-based interaction. New interaction forms provided are, e.g., throwing and the rotation of objects. BEACH uses a hypermedia document model.

The BEACH UI is designed to provide a real *interaction medium*. Consequently, interaction is rather fluent, continuous and without interrupts providing for a high speed of interaction. This is due to a modeless gesture-based interaction style. The UI is group perceptible in that it provides continuous animations, e.g., for the throwing of objects.

Using BEACH, components consisting of multiple embedded computers can be realized in order to provide large logical interaction areas, integrating several computer displays resp. SMARTBoards (DynaWall). The DynaWall resembles a large blackboard. Gestalt laws of perception suggest the perception of the currently three displays as a coherent area. Conforming to the expectations evoked by this, objects can both be thrown from one side to the other of the DynaWall and taken from one point and put to some other in order to support structuring and the exchange of information.

Due to the size of the DynaWall it affords more than one user working at the same time. The current realization supports up to three people working in parallel. Therfore, I discarded the concept of selection in the UI. This keeps the interaction local "at hand". As a consequence, it is possible to realize roomware components as the DynaWall, which can be concurrently used by multiple users.

As direct interaction at the DynaWall is only possible standing right in front of it, but content displayed can also be observed from a distance, we designed some UI elements for interaction to be only visible when standing close to the wall. This reduces the perceived information to the necessary.

BEACH also supports synchronous cooperation between people using different devices. Imagine a plenary situation, where some people sitting in ComChairs follow a presentation given at the DynaWall. This is again a situation where roomware components are used in a similar way as their non-electronic antecedents. The CommChair UI then incorporates access to one's private work space as well as full access to the wall: really interactive presentations become possible. In addition, the presenter could use an additional laptop (connected to the wireless lan), making it obvious to the system (through situational context), that only this device has the full access rights.

Roomware components are designed to be dynamicly and flexibly (re)configurable resources in order to match the resp. currently most appropriate work situation. BEACH therefore affords transistions among different situations of group work/ cooperation and individual work. In principle, it provides access from every component to a replicated shared object space, thereby allowing to synchronously work on the same document using different components. This also provides the basis for the Passage mechanism used to 'transport' information from one roomware component to the other. Moreover, this allows the ConnecTables to 'connect', as it can be seen in Figure 3: When using the ConnecTables for individual work, the default interface just provides a private workspace. When brought near to each other (as shown in Figure 3) this situation is perceived by built-in sensors automatically initiating a shared workspace allowing for the easy exchange of information by just pushing it from one display to the other (similar to what is possible at the DynaWall).

The InteracTable as well as the ConnecTable has a horizontal information display which has no predefined orientations as, e.g., top and bottom. Therefore, the "rotation" of objects allows to adapt the alignment of documents to the positions of the people standing around the table. In addition, several views on the same document can be created and simultaneously used, affording informal communication at the tables, while working on the same document.

The rotation of objects is only provided and visualized at roomware components with a horizontal display, thereby realizing an example of *device sensitive adaption of functionality*. Due to the very different qualities of the displays used in roomware components, we are additionally working on *device sensitive views* (in the sense of the model-view-controller paradigm) of the basic objects and structuring facilities provided by BEACH.

When working with the roomware components in one room, this by default means, that the 'public workspace' is only public within this room. This way, a well known architectural structure is used to structure the users' experience, even in the digital world. This 'room metaphor' is further extended to also structure access to documents, which have been created and used during a session in the room. Additionally, users are enabled to use the respective room and further elements of situational context as a search criterion.

With respect to privacy, one has to distinguish among the roomware components. CommChairs and ConnecTables are by default more private than the InteracTable, and the InteracTable is in turn a more private component than the DynaWall. These properties of the components can be used by the system to decide what information is allowed to be displayed where providing for context sensitive output. Moreover, the data created at the respective components inherit their properties by default.

Due to visibility of content displayed at public devices within the room, I decided that every user that identifies himself to the room is also a user of the public components. By default, only the private roomware components provide facilities for single users to 'log in'.

Interfacing other Devices

In addition to providing computational artifacts integrated in information environments it does make sense to give users the freedom to also use their personal devices such as, e.g., personal digital assistants (PDAs).

In most of the cases, e.g., due to apparently different form factors, it will not be possible to define a consistent interaction style over the introduced variety of devices (we experienced consistency of interaction style on the respective device as being more important). Nevertheless, the needed information objects should be available in a coherent way, providing the basis for intuitive information exchange among devices from the information environment and brought-along PDAs. In [9], we proposed pointing with a Palm to the DynaWall and pressing one of the built-in buttons to send information from the PDA to the DynaWall. This interaction form is intuitive and at the same time makes visible what happens to other people in the room. This way, also the transition to mobile work 'on the road' is adequately supported.

CONCLUSION AND FUTURE WORK

I have presented thoughts about what it will take to enable a coherent and engaging experience, while interacting with computers that have disappeared into the environment.

These are only some of the research questions we are addressing in the European project "Ambient Agoras: Dynamic Information Clouds in a Hybrid World" (http://www.Ambient-Agoras.org). It is part of the proactive initiative "The Disappearing Computer" funded within the "Future and Emerging Technology" part of the European IST program. The project started on 1.1. 2001 with a duration of 2.5 years.

The project "Ambient Agoras" aims at providing situated services, place-relevant information, and feeling of the place ('genius loci') to the users, so that they feel at home in the office, by using information technology in an innovative way, e.g., mobile and embedded in the environment. "Ambient Agoras" aims at turning every place into a social marketplace (= 'agora') of ideas and information where people can interact and communicate.

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