Seamful Design in a Seamful Society

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ABSTRACT
For a long time, the goal in ubiquitous computing has been to design seamlessly and to eliminate uncertainties in systems. Lately, focus has rather been on showing the seams to let a ubiquitous computing system be itself, accepting all its physical and computational characteristics - weaknesses or strengths.

The purpose of this essay is to define and explore the differences between seamfulness and seamlessness in interaction design, and also to decide when and where both seamful and seamless design can be useful. With this paper, I intend to investigate if there is such a thing as invisible technology, and in that case how the interaction between the user and the system takes place.

Keywords
Interaction design, ubiquitous computing, seamfulness, seamlessness, appropriation, invisibility.

1. INTRODUCTION
During my studies of ubiquitous computing, I have developed a growing interest in seamful and seamless design. I believe this topic is interesting because even though the notion is not new, I believe that it lacks proper investigation in the field of ubiquitous computing. The information found is often ambiguous and sometimes unclear. It is important to research all aspects that influence user interaction, which is why seamfulness and seamlessness are not to be neglected.

1.1 Defining Seams
When talking about seamfulness and seamlessness, the first thing to clarify is the definition of a "seam". Traditionally a seam is a line of stitches, which joins pieces of cloth together [5]. In this context, we talk about a seam as an uncertainty in sensing and ambiguity of representations [2]. Simple examples of technological seams are battery life of a mobile phone, mismatches between types of media, or network coverage. Less obvious seams are currency, system misunderstandings and mismatches between expectations [5].

Broll & Benford [8] maintain that seams in ubiquitous computing systems are typically caused by variations between heterogeneous mechanisms in the underlying infrastructures and by technical limitations. Examples of technical constraints are unpredictable signal strength, limited connectivity, and delays in communications or restricted resolution. This is visible to the user when the constraints interact with a hypothetically seamless system. The seams are then revealed as uncertainties, ambiguities or inconsistencies. The most common seams can be found in navigation and mobile communication systems, and are inaccurate positioning or bad Internet access. GPS-systems are even well-known for being inaccurate or uncertain about position. These seams are also due to technical constraints like reflecting surfaces, which make accurate sensing difficult.

2. SEAMLESSNESS AND SEAMFULLNESS
2.1 The Tradition of Seamless Design
In ubiquitous computing, there has been a long tradition of designing seamlessly. It started in the early nineties when Weiser defined his goals and visions in the field [3]. The most profound technologies are those that disappear according to Weiser [3]. Invisibility is when a tool does not intrude on one's consciousness and lets one can focus on the task not the tool [2]. Invisibility can be seen as a measurement of seamlessness, and lets one focus on interaction in general instead of on the parts. One example is a carpenter who can do his work without a constant and conscious focus on his hammer [2]. Since Weiser's ideas first were first published, seamless design has become the ruling paradigm for realizing ubiquitous computing systems. This is something that Chalmers & MacColl [2, p. 1] question and furthermore they have seen that the notion of invisibility has been translated into requirements for seamless integration of computer system components, as well as the interaction supported by those components. The authors however do not discard the concept:

"Seamlessness is an attractive prospect, extending the ideas of metaphoric direct manipulation to make our interactions with computers more literal, reducing the distractions that such interactions currently introduce."

2.2 Seamful Design
A suggestion is made to move towards seamful design instead, which has rarely been a goal in previous ubiquitous computing systems. Seamful design is a pragmatic approach that lets a ubiquitous computing system be itself, accepting all its physical and computational characteristics - weaknesses or strengths. Dieberger et al. [7] also defines a concept called social navigation when talking about seams. A seam might be revealed as limited

wireless network connectivity at a company, when people gather at one spot where the connectivity is good. This shows the need for more seamful design - but deliberately designing for social navigation is a difficult task. The authors state that social navigation is the key to a person's process of understanding and appropriating new technologies.

Because seams frequently cannot be completely hidden, it weakens the seamless ideal system [8]. Instead of fighting for a utopia and try to iron out the bumps of a ubiquitous computing application, seamful design tries to include its different parts while recognizing and maintaining their characteristics and uniqueness. There will always be uncertainties in systems, so instead of trying to eliminate them, they can be presented in different ways. However, the goal of seamless interaction but seamful technology can still be high priority [8]. The authors present three ways of achieving this goal; understanding which seams are important, presenting seams to users and designing interactions with seams. The seams that are the most important are the ones that can improve a system's functionality and when they are understood and figured out how they can become a resource for interaction by the user. If designers know how certain seams affect interactions, they can then incorporate them into an application and direct their effects into useful features of the system. This way, seamful design allows users to use seams, accommodate them and even exploit them to their own advantage [8].

2.3 Designing for Appropriation

Giving users the opportunity and freedom to play with seams, they are able to use a ubiquitous computing system in a more flexible way and increase the depth of that specific application. This more general concept of designing is called appropriation and allows the user to interact with seams individually and develop new patterns of behavior that have not been considered during the initial design of the system [2]. With appropriation, the user will be more aware of seams, and is therefore not restricted to interact with them in a compulsory way, but rather letting the user take advantage of gaps and limitations in the system [8].

More generally speaking, is appropriation about how a user adapts a system or its faults to one's own private interaction. Appropriation is adequately characterized by Curbow [4, p. 1]:

"People don't like being forced to do something in a prescribed manner, we often improvise. Appropriation describes how people designate something (a tool, a machine, some software) to be used in a particular way. We're interested at facilitating unintended uses. For example, if a ladder isn't handy, a user may stand on a chair to replace a light bulb. The user was improvising and appropriated the chair to a different purpose."

An example of appropriation is the use of mobile phones. One of the most common seams for a mobile phone is irregular network coverage and local variations in signal strength [8]. These seams are commonly accepted as reasons for not answering or dismissing a phone call, thus giving the user the opportunity to exploit knowledge about them. A user can adapt his or her behavior by pretending to have bad network coverage (for example in tunnels) or poor reception if he or she does not wish to talk to someone.

Chalmers & MacColl [2] believe that the advantages are greater than the disadvantages when designing for appropriation. Clear seams, e.g. when appropriation is designed for, are better where consistent interaction is desired for legal, medical, or educational reasons. Invisible seams are often better when designing for adaptation, personalization, or exploration. I think that the ubiquitous industry will focus to a much greater extent on designing for appropriation in the future. Being aware of seams rather than making them invisible will be a goal more and more strived towards. My contention is that edges make things clear. Take a road for example: one needs to know where the sidewalk is to be certain not to be hit by a car.

Chalmers & Galani [6] point out that underlying infrastructural mechanisms in interaction design are "literally visible, effectively invisible", meaning that everyday communication does not require attention to these mechanisms' representations - but one can instead selectively focus on and reveal them or change the infrastructure. The people using a technology construct seamlessness or invisibility, but I do not believe that you can design something to be invisible. It becomes invisible when people incorporate it into their lives, as it becomes a part of the set, which Dourish [1] calls ordinariness. To take a technological artifact for granted is to render it effectively invisible. One can explore and expose the different layers and seams if desired, but there is typically no need to do so.

2.4 The Bulletime Project

An interactive bulletin board called *Bulletime* was created by me and other group members during a course in ubiquitous computing fall 2006. It enables users to register posts with an accompanied reader, which are sent to the user's e-mail address. We were unaware of the concept of seamful and seamless design during our project. However, we have now been able to examine and detect features of seamless and seamful design. Because of the unawareness of designing seamfully or seamlessly there was naturally no goal of designing the bulletin board that way. When analyzing *Bulletime* I can however find features that are seamful, and others that are seamless. Firstly, there is a choice for the user regarding the reader: either an interesting post on the bulletin board can be scanned first, or the user's library card (with the user's e-mail address registered on it). This is an apparent seam and it also lets the user appropriate the system since one's preferences decide in which order the registration of an event takes place. Unconsciously, appropriation was achieved.

Furthermore, *Bulletime* was extended with a reminder artifact that lets the user know when it is time for a certain event that the user has registered. This is an example of seamless design since this reminder artifact is teddy bear, which is a normal and invisible part of many people's homes. The reminding function is smoothly incorporated in the teddy bear and the user will just get used to it quickly. On the other hand, one can see the reminder artifact as a seamful object because the reminding object itself does not have to be a teddy bear. It is the user's choice in what natural everyday item the reminding technology is to be incorporated. In that way it is seamful indeed, and I think it supports the theory of making the system on the whole seamless but letting individual parts become more seamful and adjustable. The reminder artifact is also easily switched between visibility and invisibility and the interaction itself is seamless. Because *Bulletime* is not a high technology project, it is hard to suggest ways to make it more seamful, but ideas of letting the user decide in what way information is sent (e-mails, mobile text messages, or even video calls), or other customization issues are good examples.

2.5 Invisibility

An example of a context when seams can be both hidden and exploited is discussed by Chalmers & MacColl [2]. Mobile phones show their reception strength by visualizing small bars in the graphical interface, and thus show the user whether the callee is heard clearly, if an Internet connection is possible or even if a call can be placed at all. In contrast to this, cell information is not displayed, e.g. what cell the phone is currently using and when the phone has switched cell. Cell handover is handled seamlessly deep within the phone's system and is not visible to the user. However, in some phones the user has the option to display the cell information, which some people choose. Users, who have the desire to seek a stronger signal, benefit from this seam by moving to a location that forces an observable handover to another cell. Other users are not interested in this information at all, perhaps because of a lack of interest or knowledge. For these users, cell information is completely unnecessary! By this example, Chalmers & MacColl [2] confirm the ambiguity of seams and illustrate users' different needs.

Switching from invisible to visible might be necessary for numerous reasons, something is broken or is breaking, or something needs to be reconfigured to let a new action occur. Oulasvirta [5] supports this theory by calling seams that are peripheral but can be consciously attended to, preattentive processing. The author also suggests that representations of seams can change without the user noticing, but can be consciously attended to if the user so wishes. An object or function can be used both implicitly and explicitly, all depending on what the user wants.

In the future, I believe that it will be possible to design technological artifacts that are so simple that a user can learn them once and then treat them as invisible for the remaining of the object's lifespan. Once made invisible, it can reside in the periphery and be as natural as going to the bathroom. However, I believe that it also will be necessary, as ubiquitous computing is becoming more sophisticated and powerful, to be able to shift these technologies into the forefront, or indeed to be able to not treat them as invisible in the first place.

3. DISCUSSION

I argue that seamlessness and seamfulness are becoming less about whether objects or functions are or are not invisible, but more about whether it is possible to make the transition from invisible to visible and back again if the need arises. This invisibility can heavily rely on the underlying ubiquitous structure, or not at all, depending on the depth of invisibility.

As Weiser [2] already advocates back in 1994; seamful systems with "beautiful seams" should be a goal. He argues further that making things seamless is to make everything the same, which is easy, where letting things be itself, with other things, is hard. I agree, and maintain my point of view: seams are useful and make technology flexible. A seamless system does not let the user to appropriate it and use all of its features in the same way a seamful system would. In a seamful world, one can use a system to its full extent and take advantage of each and every function. Weiser [8] states further on that seamfully integrated parts of a system can still provide seamless interaction with the whole system while openly retaining their individual features.

Dieberger et al. [7, p. 3] support seamful design and argue that this approach helps users take advantage of seams, appropriating and adapting system functionality for their own use and interpretation:

"Users should be actively involved in forming and supplying the content of the digital social medium, thus treating seams as features or phenomena that are created in and through social interaction."

The authors agree with Weiser's challenge about beautiful seams and plea for a broader view of seamful design, which ranges from straightforward utility to aesthetic richness. Their suggestion is to take advantage of the differences between computational media of ubiquitous computing and traditional media of everyday life, and also to design ways that lets users better appreciate these media. Furthermore, there is a desire for users to understand their use of the two media and be able to tie them together through social processes [7].

Today's society is naturally moving towards a more seamful world, and the individual is more empowered than ever. Internet supports and enables this evolution by facilitating banking, shopping and information seeking. Information technology in society supports the individual more and more, so why not let ubiquitous computing as a part of information technology do so as well? Users nowadays want to adjust and customize things individually - such as cars, houses or meals - and with this social progress in mind, interaction designers should take advantage of it and implement seamful design. It is time for designers to realize that seamful design lies in the future and is an advantage, rather than something that should be frowned upon.

4. REFERENCES

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