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■ Feature — Social Navigation Invited Paper

Social Navigation and Seamful Design

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Social navigation exploits social practices to help users navigate and explore system functionality. In a wireless world, people move around, meet others and experience places and situations. Those activities may be recorded and presented to others through wireless devices, and serve in social navigation. One design challenge is how to deal with the technical limits and 'seams' of such devices, such as gaps and breaks in functionality, imprecise positioning, and errors in recording and representation. Social navigation systems rely on recording and representing people's activity, and computational representation is affected by seams. We gained some insights into the way that social navigation and seams are socially constructed by analysing the functionality and social practice of three systems: GeoNotes, Hocman and the Seamful Game. We propose that social navigation and a 'seamful design' approach helps users take advantage of seams, appropriating and adapting system functionality for their own uses and interpretations.

Keywords: Social navigation, seamful design, seamfulness, wireless applications, mobile computing

1. Introduction

Networked services have unique possibilities of aiding users to find their way through information space or to decide what to choose or buy, by utilising the presence of a large number of other users. These other users may already have explored the service functionality; they may possess specific domain knowledge; and they may provide opinions and subjective evaluations of what the service offers, evaluations that could guide or influence others in their use of the same service.

The rise of applications designed for mobile settings offers now such opportunities. In a wireless world, people will meet others, experience places and situations, have opinions, and be more or less aware of what resources are available to them at different points in time and space. Such socially related information can be explicitly or implicitly picked up and made available to others through the wireless devices that we carry with us.

Social navigation systems are systems that exploit social practices and behaviour to help users navigate and explore. But while social navigation just seem to happen in the real world, it is not trivial to translate it into a *design* that allows for picking up explicit or implicit social trails and practices in a useful way. A major research question for the field has been to explore how the wealth of social texture can be collected and accumulated to actually aid users in navigating and making sense of space, without infringing on their privacy or overwhelming them with information (Dourish & Chalmers, 1994;

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Dieberger, Dourish, Höök, Resnick, & Wexelblat, 2000; Höök, Munro, & Benyon, 2002; Munro, Höök, & Benyon, 1999; Wexelblat & Maes, 1999)

User studies of applications created from a social navigation perspective have shown that the potential benefit is not only to follow others' trails through physical or information space (Svensson, Höök, Laaksolahti, & Waern, 2001; Svensson & Höök, 2002). Users may also benefit from sensing social presence in an otherwise lonely space (Rudström & Fagerberg, 2004). Being able to explore a texture of others' judgments may aid in selecting among whatever is offered by an application, be it music, movies, books, meeting others, or simply getting a sense for what others have done before at a particular place.

By applying the social navigation design perspective, wireless applications may register peoples' activities in different places, allow users to actively comment or leave their marks in both digital and physical media, and enhance users' physical meetings with one another in various ways. In effect, when the digital medium goes wireless, it allows for a *social space* to be created. The technology used to create this social space is a prerequisite but not a model for it. Neither does social space have a 1:1 mapping to physical space: information may sometimes be tightly connected to specific locations, but more intrinsic relationships are just as possible.

This paper starts with a background in social navigation, and a discussion of what we mean by seams. Then, we present some examples of how social activity reveals how users already exploit social practice around wireless network technologies. We then discuss the design of wireless applications that explicitly pick up on social context, making it part of their functionality. Through our experience of deploying these applications, we hope to reveal some of the unique properties and advantages of the new wireless medium.

In particular, we examine how to design the seams that occur in social navigation. Social navigation relies on recording users' activity, and representing it to other users, and designers have to deal with the technical limits and 'seams' of recording and representing user activity, such as gaps and breaks in functionality, imprecise positioning, and errors in recording and representation. Such seams are most obvious when designing for mobile wireless devices, but the same problems apply for all interactive systems. Social navigation relies on recording and representing people's activity, and computational recording and representation are affected by seams. Therefore seams are a key issue for the design and understanding of social navigation systems.

Our approach is to regard seams as something that can be socially constructed and shared between users. Instead of always striving for seamless connections and 'perfect' representation, seamfulness will be a guiding design principle. 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.

We conclude with a general plea for a broader view of seamful design that ranges from straightforward utility to aesthetic richness. In other words, we argue for a mature design discipline that faces up to the challenge of making "seamful systems, with beautiful seams", to borrow Mark Weiser's words (Weiser, 1994). We suggest not only to make use of the differences and tensions between the computational media of ubiquitous computing and the traditional media of everyday life, but to design in ways that let us better appreciate these media, our use of them and our own lives — tying them together through social processes.

2. What is social navigation?

Human beings make extensive use of social navigation in real life, e.g. to find the exit when the movie ends by following the crowd. When the World Wide Web started to grow, navigation in the web-based information space emerged as a

real and difficult problem. However, it could be assumed that a great number of users were online at the same time. Transferring social practice into information systems use arose as a possibility. By making users aware of each other, they should be able to help one another — either directly on the spot, or by leaving their experiences and comments behind for others to come.

The concept of social navigation was first introduced by Dourish and Chalmers (Dourish & Chalmers, 1994). They saw social navigation as *navigation towards a cluster of people* or *navigation because other people have looked at something*. In parallel with their work, Hill and colleagues developed the first recommender system, *Tapestry* (Hill, Stead, Rosenstein, & Furnas, 1995). An individual specifies one or two things that s/he likes or dislikes. By collecting the likes and dislikes of a large number of people, Tapestry is able to recommend new items based on similarities between that individual and others.

Hill and colleagues continued to work with visualizing various trails of previous users' presence and use, although they did not use the term social navigation to describe their work. They did, for example, design a community enhanced Mosaic [1] Interface where users could rate different URLs. Individual user ratings were then aggregated and expressed as a set of stars next to each link. These ideas have later been exploited in e-commerce, starting with Amazon.com (Linden, Smith, & York, 2003), where similarity in book interest can be computed from purchase behaviour combined with user ratings. Hill and colleagues also suggested putting "wear" on digital objects (Hill, Hollan, Wroblewski, & McCandless, 1992): digital objects should look worn when many people had downloaded, read, touched, worked with, bought or edited them.

Later, Dieberger (Dieberger, 1997) widened the scope set up by Dourish and Chalmers. He also saw more direct recommendations of e.g. web sites and bookmark collections as a form of social navigation. He was inspired by Tom Erickson's remarks that the web could be characterized as a *social hypertext* (Erickson, 1996). Erickson had noted that many personal pages on the web at the time had a list of pointers to "interesting people and places", in effect inviting others to view that person's network of friends, colleagues, and concerns.

An important property that distinguishes social navigation from other phenomena is its *dynamic nature* (Svensson & Höök, 2002). Only when the social practice is changing over time, as in real-time communication or in continuously collected trails from groups of users, do we talk about it as social navigation. This can be compared to forest paths versus roads in cities. Forest paths are transient features in the environment: they vanish if they are not used. Their state (how worn they are) may indicate how frequently or recently they have been used, something that is typically not possible with a paved road.

The dynamic nature of social navigation design may lead to applications that change over time like everyday language or the way a city grows. Language is a dynamic, on-going, social process: it has been around for a long time, it is democratic in that anyone can add to it, words can shift in meaning as they are being used, it is a tool that never ceases to work, it is multipurpose, and it is beautiful. Cities grow in similar ways. They are not released in new stable versions once every year. Instead they slowly change when people build new houses, take new paths into usage, move cafés and restaurants, or simply decide to hang around or create events in different parts of the city. Digital systems in general should also have this quality: as they are used, their users change their functionality. Social navigation is one way of achieving this. As a system is used, the usage will leave trails in the system that will guide future usage by others. As usage changes, the trails will change.

Thus social navigation relies on the way that

1) Mosaic was one of the first web browsers.

people occupy and transform spaces, leaving their marks upon them - turning a "space" into a "place" in the terminology of Harrison and Dourish (Harrison & Dourish, 1996). In time, the social cues they leave behind can become sedimented and formalised, transformed into social practices (such as letting people get off the train before you get on), rules and regulations (such as those governing driving) or artefacts (such as signs and landmarks). Social navigation, in the sense of our individual actions being designed around collective social behaviour, is not just something that is "layered on top of" a space, but comes to transform both the space and the ways that people act within it. To design with such ideas is to leave yourself open to the possibility that actors will render your system unrecognisable by you and your co-designers (Dieberger et al., 2000).

Exploiting social navigation in wireless applications basically brings us full circle. Social navigation as used in web-design was inspired by how we watch, follow and become inspired by others in ordinary life. With the introduction of wireless computing, the digital medium is added to the existing set of media. Using this new medium we can capture and store on-going social activities that would otherwise disappear once performed-as a crowd dissolves after the street musicians have left-or never be expressed at all. A growing number of wireless applications, such as the GeoNotes system described below (Persson, Espinoza, Fagerberg, Sandin, & Cöster, 2002; Persson & Fagerberg, 2002; Fagerberg, Espinoza, & Persson, 2003), E-graffiti (Burrell & Gay, 2001), and Jabberwocky (Paulos & Goodman, 2004) provide examples of how computational media and the traditional media of everyday life can be tied together through social processes, allowing users to dynamically occupy and transform the physical space by adding social information-creating a social space.

3. The Nature of Seams

There are of course many ways a social navigation design stance could be taken into account when designing wireless applications. As indicated above, we are particularly interested in how to make wireless application designs exploit, or *afford*, users' explicit construction of the *seams* between traditional and new (digital) media, with their enabling technologies. Currently those seams are most apparent when using network technologies such as WLAN, Bluetooth, infrared, GSM or 3G. Our general belief is that seams between the digital and the tangible, and seams between e.g. different WLAN hotspots, Bluetooth connections, or GSM base stations, can be turned into a resource in wireless application functionalities - most usefully so if users are allowed to construct their meaning dynamically and socially over time.

In many parts of the world, wireless systems have become everyday tools. Whether mobile phones using telecommunication companies' public networks, or mobile computers on more private and localised wireless Ethernet networks, wireless devices are typically designed and marketed to suggest there are no limits to mobility. Yet, service coverage is anything but seamless, pervasive or ubiquitous, as there are noticeable variations and gaps in service provision. Infrastructure is often made up of discrete regions and services, interconnected to make one larger service that works perfectly everywhere and anytime-ideally. However, there are often gaps and seams that show through in users' interaction. We argue that such seams are essentially inevitable features of the design and use of mobile technology and that it is unfortunate that they only shine through by mistake. Consequently, we suggest in general that system designers should consider the option of *deliberately* revealing and exploiting them in ways that users find useful or interesting. We propose 'seamful design' that goes beyond a pragmatic acceptance

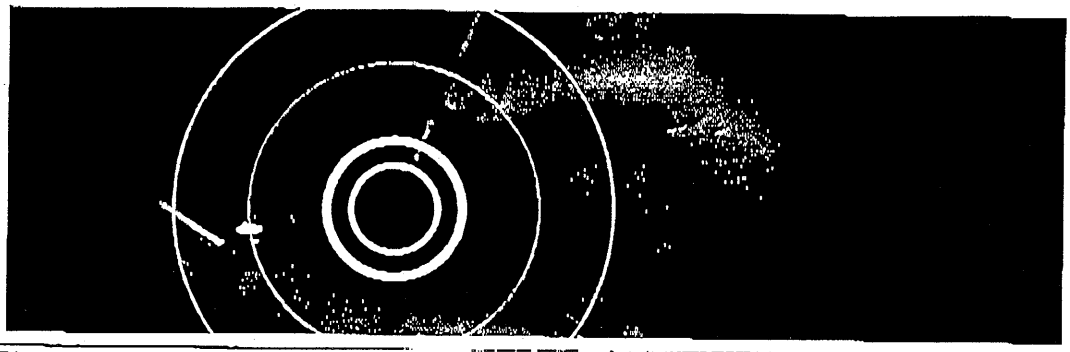

Figure 1 Interacting with a combined PDA and mobile phone, here a Sony Ericsson P900, places high demands on users' technological knowledge: the phone can be connected to wireless infrastructures using Bluetooth, Infrared, GPRS or GSM technology.

of the physical limits and variability of digital media, and instead lets users take advantage of them and appropriate them for their own uses and interpretations.

Traditional system design argues that seams are just technical by-products, and that getting rid of them is just a matter of time and improved service. In some cases-such as maintaining the connection during a mobile telephone call-this defensive or negative approach may be the best design option. Users may indeed benefit most from removing such delays and inaccuracies. However, this approach disregards the possibility that the seams themselves can be seen as a resource for users, rather than as a weakness of the design. Bluetooth connectivity currently has a 10-meter range. To a user, what resources can be reached using Bluetooth (other phones, printers, laptops or servers) roughly corresponds to what objects are "nearby" in the traditional sense. Infrared connectivity only works if devices are aligned, and thus users can turn devices towards or away from one another in order to create or prevent links for interaction. Similarly, free web surfing may be exploited through scanning for WLAN-hotspots around town.

Currently, actively looking for and exploiting the seams that arise when an end-users' device has any of these wireless connection capabilities requires extensive knowledge of the technological limitations (e.g. 10 meter range with Bluetooth) and how the seams may (involuntarily) reveal themselves.

4. Seamful Design

Network seams may sometimes be exposed by social activity in real life. At a recent conference most of the authors attended, network coverage was patchy. After several failed attempts to connect, people noticed a flock of conference attendees with laptops clustered at some tables in one corner of the entrance hall. Connectivity in the rest of the conference centre had broken down, but this area was close enough to the conference office to connect to the office's functioning hotspot. Other areas near the office had good coverage, but the combination of wireless coverage with the tables offered a convenient place to set up a laptop, have a cup of coffee, talk with friends, etc. This is a clear example of social navigation, because the distribution of useful network functionality was made apparent through people's activities. Later that day, people were able to connect in the entire entrance area, and the distribution of people using laptops for email again made this fact very obvious. A general issue to note here is that social navigation bridges and connects different media: traditional, everyday media were used to understand the state and use of the new media.

In this example, social activities in the physical space helped to reveal network coverage and

thereby in a roundabout way exposed the seams of the network - in effect showing the need for more seamful design. As discussed in the introduction, deliberately designing for social navigation and social constructions of seams is a different, more difficult, issue. The social wireless applications *GeoNotes*, *Hocman* and the *Seamful Game* provide some interesting insights into how a social medium can be used in system design to deliberately reveal or even allow for end-users become co-constructors of the seams as such. The applications also reveal some unexpected properties of the social medium. Let us discuss each in turn.

4.1 GeoNotes

One of the first mobile services for attaching digital 'Post-It' notes to geographical locations was *GeoNotes* (Persson et al., 2002). Technically, the geographical locations were fairly large areas, each determined by the coverage of a wireless WLAN hotspot. Instead of just posting the notes to the hotspot as a whole, users were allowed to name places within each hotspot. While these place labels could not be physically tied to any exact location within the hotspot, most labels made sense to other users entering the hotspot. Some place labels were initially provided by the system, but users could dynamically add place labels as they saw fit. Each user-created place label was only available within the hotspot where it was created.

In a one-month field test with 78 users, seams between the underlying hotspot model and the user perceived model of how places should be named were elegantly handled by the users (Persson & Fagerberg, 2002; Fagerberg et al., 2003). Place labels were created to post notes that covered smaller areas than the positioning system could handle, such as "the sofa" or somewhat more esoteric "the lecturer's forehead". Large places were created by re-entering identical place label names at several hotspots. One group of users also created a virtual place, their own "VIP-room", through adding this place label to all the hotspots they encountered. By not forcing any official labelling system upon users, they were set free to explore the seams between hotspot coverage and perceived places — thus dynamically creating the ties between information and place.

First, and most important to note here is that the placement of virtual post-it notes under different place labels did not follow the rules for paper Post-It notes. In particular, the place labels invented by users did not map virtual places in a one-to-one relationship to the geographical or physical world. The *virtual space is both bigger and smaller, and more plastic than the physical space*. This is a property of the social space that must be accounted for in the design of social navigation for wireless applications.

Second, virtual Post-It note practice will develop dynamically with system use, as indeed it did in the GeoNotes user trial. Both notes and place labels were added dynamically during use.

4.2 Hocman

Hocman is a mobile service for motorcyclists-bikers-based on ethnographical studies of the biker culture (Esbjörnsson, Juhlin, & Östergren, 2002, 2003, 2004). An important part of this culture is to "show off", on the road, at gatherings and on the web. Bikers all over the world also acknowledge each other when they meet on the road. To support these ephemeral meetings, Hocman allows personal web pages to be swapped as bikers pass each other on the road, via a dynamically created ad hoc wireless network. The web page swap is accompanied by a sound alert in the user's earphone.

In a field trial, it was found that in particular the notification through the sound alert was found interesting and valuable, strengthening the social (albeit brief) meeting between the bikers. As one biker in the trial passed another not participating in the study, the absence of the sound alert was reported to be disappointing.

In our view, one of the more interesting incidents in the study was when one participating biker happened to be hidden from view. Another participant passing by became very confused when he heard the sound alert indicating a meeting-no other biker seemed to be there. In the world as we know it using traditional media, there are established customs and practices about acknowledging presence, avoiding rude interruption, and establishing interaction and conversation. These rules let us handle differences between sound, vision and other traditional media (Goffman, 1956). Like sound, interaction based on wireless networks does not depend on visibility, but such a system may not be designed to afford gradual and mutual construction and adaptation of social engagement, as we are familiar with in everyday interaction. Long-term use of Hocman may cause such practices to become established-as they have with many earlier forms of computer-mediated communication (Dourish, Adler, Belloti, & Henderson, 1996).

The Hocman experience shows how the social space may change the meeting between people, *from being face-to-face to being screen-to-screen*[2], and that this in turn may even change expectations and social practice in physical meetings. The ad-hoc-connectedness deployed in Hocman and its 'seams' in terms of reach and timing, may reach further (behind walls or bushes along the road) than a normal visual meeting between bikers and depending on which wireless technology is used, its time span might be longer or shorter than the visual meeting is.

4.3 The Seamful Game

An elaborated example of how "seems" could be taken advantage of is the *Seamful Game* (Chalmers, MacColl, & Bell, 2003), which employs a set of WLAN hotspots[3] in fixed positions around a university campus. Two teams of players use PDAs, with GPS units attached, to build up a map of coverage. They also gain information from a central game server about periodically appearing 'coins'. In order to gain points, a player has to get close to a coin (according to GPS), use a GUI command to pick it up and send a report to the server. Players can only find out about coins, and report coins, when they are in network coverage-but coins often appear in areas where there is no coverage. A player has to decide whether to move out of network coverage to pick up one or more coins, or wait to see if more will appear. Also, certain commands only work within network coverage, such as a 'pickpocket' that lets one player steal coins from another's PDA.

An important design issue in the Seamful Game is the way that players build up a map of hotspot coverage, and understanding of that coverage, to play the game. Areas of no network coverage and bad GPS are good to know about and to use: they are places that one must go to in order to pick up coins, but they are also good places to hide or to sneak up on someone. Players develop tactics that take advantage of such gaps and seams, such as becoming specialist pickpockets who attack others by running out of places near to access points where they cannot be seen either visually or via GPS.

The Seamful Game shows how users can control how and when they are connected to other systems, and hence perceivable by others. Revealing such seams lets people control how and when they present themselves to others. *Seamful designs go beyond mere accommodation of seams; they let users find ways to take advantage of seams and appropriate them for their own ends.* The social element of such appropriation is an important factor.

4.4 Properties of the social digital medium

It is strange how often we expect new media to conform to face-to-face visual interaction, and be based on such phenomena as eye contact

2) Oscar Juhlin of the Interactive Institute (Stockholm), personal communication.

3) VPN-connected 802.11 wireless access points

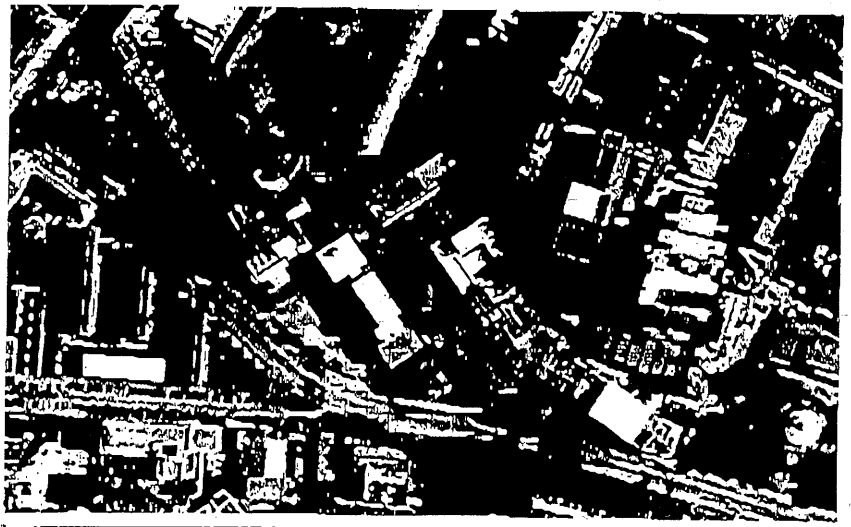

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Figure 2 Map of wireless coverage in the Seamful Game

and gaze awareness. Instead, we should expect that users of a new medium "create new patterns of behaviour organised around the nature of the medium itself", built up through social navigation, construction and interaction-the circular process involving patterns of use that are influenced by the past use of others, and that are also resources for the future activity of others. As Dourish et al point out (Dourish et al., 1996), we should not assume a "real world baseline", in which interaction involving new media, or a system involving a combination of old and new media, has to conform to traditional media.

Our examples above show that using a deliberate social navigation design stance in designing seamfulness creates a new, social medium. This medium is both smaller and bigger than its physical, tangible counterparts; it is more plastic and dynamically changing than most traditional media; it enables changing behaviour patterns in meetings between people, from face-to-face to screen-to-screen; and it allows end-users to take advantage of seams and appropriate them for their own ends.

Social navigation of seams thus stretches into the new media itself, which is socially constructed by both implicit awareness and explicit negotiation. As designers, we should never forget that users are anything but passive consumers of media. Instead, they–we–are *actors* who take whatever tools made available to us and re-create them to suit our needs, by weaving them into the other media of everyday life.

5. A Plea for Beautiful Seams

Architecture has spent thousands of years developing not only the functional qualities of buildings but also their aesthetic qualities. The design and construction of a building often involve many different materials, technologies and skills, but generally we do not have to think about the parts: we live in and appreciate the whole. In contrast, hybrid designs that combine digital and traditional media have only been explored for a couple of years. We are all too aware of the difficulties of combining the many parts of such systems so that they seem to disappear or become invisible in everyday social interaction, as has generally been held as the ideal for ubiquitous computing ever since the days of Mark Weiser (Weiser, 1991, 1994).

In this paper we have tried to show how seams between old and new media show through in social interaction, and how seams within the new

wireless medium are not necessarily a technical glitch but might be a resource to users. The fundamental infrastructures and services that make up ubiquitous and pervasive technology exhibit a great deal of spatial, temporal, economic and organisational variation. Social navigation is key to a person's process of understanding and appropriating new technologies. This process involves not just the new media, but also demands consideration of the whole set of media that people use in the course of their activity. We suggest, therefore, that a more general lesson should be learnt from our experience with ubiquitous computing: system design should be more pragmatic, holistic and social than it usually is now.

We should accept that connectivity is not constantly perfect. People need to know where services can and cannot be used, and they will use the activity of other people as an indicator of this information. We also need to accept that the use of a new technology influences and is influenced by other media. People often need to use older media, such as furniture, signage and face-to-face conversation, integrated with the possibilities offered by social wireless services. If the use of new media clashes badly with the use of the old, users might stop using our newly designed systems. The design approach described in this paper was to involve end-users through making them active co-constructors of the emerging, hybrid architectures that mix old and new media. As a space changes over time and use, designers need the active cooperation of the users of this design, not only for updating information but to make it useful, comfortable and beautiful. We should help people integrate the use of 'novel sensing' into their work, leisure, play and socialising, and help them find ways to use our technology for their ends in their lives.

This paper focused on one small aspect of this wide area of future research, opening up the seams in system designs and infrastructures for social navigation and appropriation. Again we emphasise that we do not see seamlessness as always bad and seamfulness as always good. We do believe, however, that seams displayed in an interface have to be carefully chosen and well designed. Given a particular user population and a set of possible seams and activities, designers should ask themselves whether revealing seams in a design will offer useful opportunities for user understanding or merely be distracting and intrusive. In particular, supporting appropriation may be a bad design choice in some situations (e.g. where consistent interaction is desirable for legal, medical or educational reasons), but be a good choice in other where personalisation, adaptation and exploration are desired functionalities. Deliberately affording knowledge and use of seams should not be a defensive or merely pragmatic choice-making a 'design feature' of a flaw but a positive and empowering design option.

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Matthew Chalmers is a Reader in Computing Science at the University of Glasgow, and Co-Director of Research at the Kelvin Institute. His research explores social and perceptual issues both in the design of computer systems, in visualisation, recommender systems and ubiquitous computing, and in the theory of computer science, relating contemporary philosophy to computational representation. He previously ran the Visualisation group at UBS Ubilab, was a visiting fellow at U. Hokkaido, and was a research scientist at Xerox EuroPARC.

Andreas Dieberger

Andreas Dieberger is a Research Staff Member at the IBM Almaden Research Center in San Jose, California. His research interests include information visualization and computer supported collaborative work. Currently he is spending a one year educational leave in Vienna, Austria to study art.

Kristina Höök

Kristina Höök is currently a professor in Human-Computer Interaction at the Department of Computer and Systems Sciences, Stockholm University/KTH. She leads a group working on affective interaction, with a particular focus on mobile applications. Kristina has also kept a part-time position at the Swedish Institute for Computer Science (SICS), where she previously was the laboratory manager of the HUMLE laboratory. Her previous work while at SICS focused on social navigation.

Åsa Rudström

Åsa Rudström is a researcher at the Swedish Institute for Computer Science (SICS) and is finishing her PhD at Stockholm University/KTH. Her research focus is on the use of social information and practice to enhance the user experience in human-computer interaction. She is currently working with mobile social services.