

Awareness Systems: Design and Research Issues

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Abstract

This paper summarizes an invited lecture for the SID 2007 conference, with the same title; it discusses awareness systems for supporting informal social relationships, focusing on some of their key concerns for designers and researchers. The discussion is general, but examples from research done on this topic at the Eindhoven University of Technology are discussed. The paper argues in favor of automated capture of awareness information and suggests that social intelligence is relevant a) as a design and evaluation criterion for such systems and b) as a mechanism for supporting users in managing the information sharing behavior of awareness systems.

Keywords: Awareness Systems, Ambient Intelligence, Connectedness, Social Intelligence.

1 INTRODUCTION

This talk discusses the design of awareness systems for intra-family communication. The term ‘awareness system’ is used here in a broad sense that encompasses communication systems that help individuals maintain a mental model of the activities and status of other people. In our research we have focused upon communication between people related with primary social relationships and especially family ties.

Awareness systems can be described by contrasting them to systems intended to support more efficient and focused communication activities, like the phone and video conferencing. Even though awareness can be obtained by using such media we are interested here in the feasibility of a continual ‘trickle’ of information that does not require continuous and contemporaneous engagement by communicating actors allowing them to focus on other activities. Awareness information can be attended to sporadically, with minimal effort often requiring just pre-attentive processing for its perception and minimal or no effort for sending it.

Several examples of such systems have been discussed recently in the research literature. One (perhaps the first) commercial example is the Nabaztag robot (www.nabaztag.eu/) which can display selected information available on the Internet as a peripheral and embodied display. Other examples are buddy lists on instant messaging systems that display some information on the status of one’s online social network at a glance. More dedicated research prototypes include the recent Whereabouts clock by Microsoft [1], an appliance that displays very coarse grained information regarding the location of members of a household during the day: at home, at school, at work or other.

In the remainder of the paper we discuss a few issues that should be considered when designing such systems.

2 IS THERE A GENUINE NEED FOR AWARENESS SYSTEMS?

It cannot be denied that the increasing interest in awareness systems is related to the availability of bandwidth, connectivity and computing. One could argue that in the recent technologies supporting communication there is a natural evolution from telegraph, to telephone, to mobile telephony an evolution that increases the frequency and the amount of information transfer between communicating parties. Awareness systems can represent the next step in this progression, but will only succeed in fulfilling that role if they provide genuine value to their users.

People need awareness to provide a context for their activities, and this awareness can support them at their work or at leisure, as they engage in any type of activity in pursuit of their most fundamental human needs: to affiliate with



Figure 1. The ASTRA system [11] supports communication between members of different households. While on the move, individuals can send snapped pictures or written notes to the related households. On the home device, notes in the form of a 'postcard' appear on a timeline spiral visible for all the family. These 'postcards' can trigger communication, can be discussed during a phone call or simply browsed 'off-line'.

others, to accomplish and gain status, to defend themselves, etc. Given the existence of these fundamental human needs driving the pursuits of individuals, awareness systems will succeed in providing value when:

- They move beyond displaying data and to providing information: awareness information that is meaningful in the context of some joint activity or social relationship.
- This information is consumed, recruited and used by people at the course of other activities they engage in.

More specifically, in the context of supporting family communication, awareness systems can be considered successful, when people assimilate the use of related information in their daily routines and when they assign meaning and value to the information obtained through awareness systems. For example, consider the case of providing awareness of the location or activity of family members during the day on some awareness display at home. This has been proposed by numerous researchers, yet before following the beaten path, designers ought to question on what basis this can be considered a valuable proposition for users. Based on the conception of awareness discussed here, an awareness display is little more than an irrelevant piece of information on the wall, until family members start adapting their routines to the information they see, refer to it and consult it in the course of their activities, or gain some affective benefits pertaining to their relationship with other family members. Evaluations therefore need to examine whether such assimilation takes place, what meanings are assigned to the awareness display and what uses and rituals are built around it.

To conclude, the need arises for designers to be explicit about the value they wish to provide to their users and for design proposals to be evaluated regarding these benefits. In the absence of such an explicit account of benefits provided, eventually accompanied by empirical evidence, design research in this field runs the danger of degenerating into a self-referential reproduction of ideas that favors the grotesque and the surprising over one that fits the life and needs of people. The research discussed in the remainder of this paper assumes this value-centred perspective.

3 EXPECTED BENEFITS AND COSTS FROM AWARENESS SYSTEMS

Families living in the same household have a high degree of awareness regarding each other. This awareness is multi-faceted. It may concern the location of family members, their activities but also a deeper level concerning their pursuits, tribulations, achievements and disappointments. The need to exchange information addresses all these levels and may concern activities spanning different periods of time and different aspects of each individual's life. In

our research we have been pursuing the design of awareness systems that might provide to remote individuals some of this kind of awareness. Regular communication by phones, email or other more traditional forms of interaction including face to face meetings and letter writing already provide some of that awareness. It is clear though that compared to people living closely together, awareness of this sort is impoverished when individuals are separated by distance.

One clear benefit from increased awareness is strengthening the cohesion of connected groups. This has been shown experimentally, in the case of people watching the same event, (so potentially sharing an experience) while they are connected by a media space for the home [5]. In that experiment, awareness concerned a brief period of time and a specific activity only, so it falls short of the vision of awareness discussed above. A first attempt to operationalize the kind of awareness we aim to provide, was based on a qualitative inquiry into the communication needs of partners separated by distance and in the communication needs of three generation families split across at least 2 households. The notion of connectedness that results from using a communication medium over some sustained period was defined in terms of affective costs and benefits resulting from the communication.

The costs resulting from the communication referred to:

- Privacy. One's feeling that connected others have more information about oneself than desired and vice versa.
- Obligations. The extent to which one feels that the system creates social obligations, e.g., to return a call, to take a call at a difficult moment. This concept relates to the notion of Solitude control as defined by Boyle and Greenberg [1].
- Expectations. The extent to which one's expectations that others will engage in communication/interaction or will respond to or reciprocate one's own actions.

Note that the dimension of privacy here concerns information privacy while the latter two concern interpersonal privacy or solitude control, using the vocabulary of Boyle and Greenberg [1].

The benefits resulting from the communication refer to connected actors:

- Thinking about each other.
- Knowing the whereabouts, status, activity of each other.
- Feeling connected/in touch with each other.
- Sharing experiences.
- Understand, recognize and empathize with each other.
- Form a cohesive group, to which they feel attracted.

Finally, a very important dimension for characterizing benefits and costs is 'effort'. We distinguish two kinds of effort:

- Procedural Effort, which is best considered as a cost of using any communication system. The effort required to operate the communication system, e.g., setting up the system, logging in, etc.
- Personal Effort, which is when recognized is appreciated as a token of affection or friendship, or at least personal interest.

The ABC questionnaire (van Baren et al 2004) was developed to assess costs and benefits. It includes 4 items for each of the dimensions listed above except for the dimension of effort, which as the discussion above shows is a complex concept, that cannot be unequivocally described as either a cost or a benefit. The ABC questionnaire has been applied in several studies as a way to evaluate awareness systems.

For example in the evaluation of the ASTRA system [11] illustrated in figure 1, in intra family communication service and its related appliance, the questionnaire was administered prior to the use of the system and referring to the communication during the week before and once after a week of using the ASTRA. In that case, the assessment of costs did not alter significantly for participants inquired while most benefits (apart from the one referring to empathy/recognition, seemed to improve).

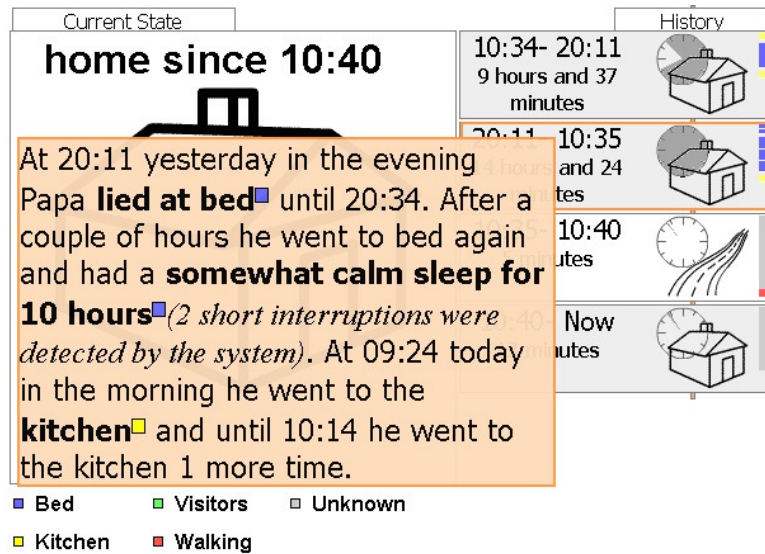


Figure 2. Close up view of the Diarist [7] with the narrative explanation for the block of time 20-11-10:35 popped up.'

4 MANUAL AND AUTOMATED INPUT OF AWARENESS INFORMATION

The downside of systems like ASTRA which are based on messaging is that the actors have to keep supplying their social network with information about their lives. While ASTRA was designed to lower the threshold of capturing and consuming fleeting experiences during the day, manual input of all awareness information does not scale up in time or with regards to the number of people connected; such explicit effort offers little value over other communication media such as phone and MMS. True awareness then needs to rely at least in part in automated capture of information of a person and to support a partly automated flow of information towards connected others.

Such an approach was implemented in the Diarist system [7]. Diarist was designed to support seniors living alone, by informing their adult children about selected aspects of their daily life activities in the home; the aim was to achieve connectedness and peace of mind for both. A sensor based network was installed at their home; the application created would collect and interpret the sensor readings and construct a record of the whereabouts of the elderly. This record was displayed at the home of their adult children using a Philips iPronto device. The information was displayed at different levels of granularity:

- A large icon showing one of the following regarding the home occupant: at home, away, with friends, in the kitchen or in bed.
- A log of the whereabouts for the last 24 hours displayed as a list of blocks showing duration, and a fitting description, e.g., home, or away. This is visible when one walks up to or holds the device.
- A detailed narrative (see figure 2), showing a detailed account of the information collected that lets the user inspect the premises of this reasoning, (e.g., that his/her father got out of bed twice tonight, lets the system infer that he slept somewhat calmly).

Designers of awareness systems should be conscious of the trade-offs related to choosing between explicit and implicit input of awareness information. Explicit input (e.g., setting your status e.g., at home or not, sending a message, or updating a blog), lets the user control which information to share and to adjust his/her presentation to the intended audience and context. People are extremely good at doing this, and a mediating system can go very wrong when it attempts to substitute user explicit input. Subtleties of language are hard to reproduce, timing, accuracy of information, precision, empathy with the audience; each of these aspects becomes one way in which people demonstrate their social skills, when communicating unaided by an awareness system. Social skills of this kind are an



Figure 3. An awareness system for parent regarding their children at school [3]. The awareness display is a graphical widget for a Windows platform that ‘floats’ over any other Window on the PC. It displays a) whether a child is in the vicinity of the class and b) the scheduled activity of the child at school.

essential component of human social intelligence and one that automated systems are far from being able to emulate at this moment.

A limitation of manual awareness information is that actors may forget to update it, or may make mistakes while entering it. Automated systems offer the possibility of scaling up; they can capture information that can be tedious for humans to capture or that only makes sense if there is some reliable capture mechanism, e.g., for health monitoring an indication that someone’s heart rate is within safe bounds or not, or for a dementia patients whose location is tracked by the system.

An underestimated aspect of sharing awareness information is how meaning and intention is attached to it. Here are some points to consider:

- Quality of information. A system like Diarist or systems monitoring Health parameters can only provide reassurance and peace of mind because we can assume that they provide accurate and up to date information. If the person concerned would prevent the system from sharing some kinds of information, e.g., an elderly not showing that he does not feel well to stop others from worrying unnecessarily, then the system provides little added value to those who rely on its information. When reasoning is flawed or technical errors are obscured, a system like Diarist can cancel out all potential benefits; e.g., during the field trial of Diarist [7] an erroneous reading that the elderly father was out all night made his daughter to be unnecessarily concerned.
- Intentionality. Sending a regular and automated log of activities of one’s holidays will be less appreciated than a personally addressed and well timed message, (see [11]). To give an example from a different domain, sending an invitation for coffee to a colleague will be less warm and inviting than an automatically generated announcement that you are having a break. Intentionality can be expressed in the content, the timing of the message and also, by considering the context in which it will be displayed.
- Control. Connected actors may feel their privacy is under threat. Being able to choose when to declare your presence at home gives more control over one’s privacy borders than say a device that detects them for you.

5 PRECISION, ACCURACY, SYMBOLISM

We can distinguish awareness information by (at least) the dimensions of *precision*, *accuracy* and *literalness*. Figure 3 illustrates how awareness information regarding children at school was presented to parents on their PC at home and at work during a recent investigation [3]. Awareness information consisted of two parts: presence and activity. Children carried a Bluetooth headset which was detected by the PC computer at their class. This device gives real time information regarding their presence in the classroom: when the bluetooth headset is in range of the classroom computer a colourful icon is shown on the desktop of the remote parent. A grey icon indicates the child is out of range. The text line below the image showed the scheduled (not actual) activity of the child according to the school’s schedule. Below, we use this example to explain the concepts introduced in this section.

Precision. Precision can be understood in terms of the granularity of the awareness information, how rich a communication channel it is. For example, in figure 3, the icon indicating whether the child is in the class or not carries 1 bit of information. The Whereabouts clock by Microsoft [13] carries 2 bits of information relying on the cell network to distinguish between 4 locations: home, work, school and other. In the Diarist system discussed above,

the top level view represented a choice of 6 locations, while the blog and the narrative represented increasing levels of detail. In media spaces, a blurred image offers less precision over the full video image, see for example [13]

Designers often opt for low precision to protect the privacy of their users. On the other hand, it is often the case that more precise information is needed. In the evaluation of the awareness system of Figure 3 parents required more information, e.g., whether their child is alone, who the child interacts with, etc. (See [3]). In this case, they required higher precision. Other parents who preferred to know whether the child was out of bounds of the school, required lower location precision, as this was more relevant to their concerns. Going out of bounds would be a reason for concern. In a flexible system users may prefer to vary the precision of the information about them as a means for managing their own awareness and privacy needs.

Accuracy. The scheduled activities of the children in Figure 3, can be reasonably precise and rich descriptions but they are the ones scheduled for the school a week in advance. As such, they may not be accurate, e.g., because some activity runs late, or a teacher falls ill, etc. As has been argued by Price et al [10], users may also wish to vary the accuracy of the awareness information in order to protect their privacy. In the case of the Diarist, erroneous system operation reduced the accuracy of the readings raising concerns among users. Accuracy often trades-off with precision. The Diarist attempted a rich and quite precise description of user activity for which accuracy is a higher technical challenge. Users will face a similar trade off – forced to increase the precision of awareness information they may prefer the ability to modify it, effectively lying to protect their privacy.

Literalness (symbolic versus literal display). Figure 3 combines a symbolic display (the icon representing presence of the child in the class) and a literal display, listing the child's activity in text. Literal displays tend to be more precise. If there is little need for precision, designers may often opt for a more decorative presentation of awareness information, by some abstract pattern or a picture that is a symbolic visualization of awareness data, e.g., the Info Canvas [8]. Apart from their function as decoration, abstract and symbolic displays are differently understandable to their owners and others, offering in this way some privacy guards. For example, after long term exposure users may gradually learn how to interpret abstract displays (e.g., light patterns), that are at first sight meaningless to others. In a range of studies concerning family communication, informants have consistently indicated preference towards literal and directly accessible displays. However, none of these comparisons referred to actual use which might indeed show these more artful variants of awareness systems to be useful and welcome by their users.

6 RESEARCH AND EVALUATION METHODOLOGY

A point of consensus in the research community is that the evaluation of awareness systems in the laboratory is not sufficient, in cases where they are intended to be used over a sustained period of time, and with tasks that relate to the social interactions between individuals. Evaluations of systems in the lab may be a good first step, where a design team can aim to a) establish the smooth operation of the system and increase its reliability b) find out and correct usability defects that might hamper the evaluation in the field.

A trend that can be observed in the research literature is that earlier works did not include evaluation or included a minimal evaluation based on interviews or focus groups based upon scenarios, non-functional prototypes or demonstrations of an intended system. In the last 2 years, evaluations studies have concerned mostly working systems and longer periods of time, even going up to 6 months. (e.g. see for example [2][9]). The message coming from these evaluation studies is very upbeat. These evaluations suggest that people find uses for awareness systems, fit them in their daily life, appropriate them and develop their own conventions for their use. Some caution has to be exercised: these evaluations have typically concerned small proportions of one's social network, have usually not compared non-use with use, so participants could be positive in their subjective assessments to please the creators of the systems or even are very likely to change their behavior as a result of being under study more than because of using the system in question (which amounts to what is often called a Cawthorne effect). There are some measures that one is advised to take to avoid this problem:

- Extend the evaluation period, if participants are excited about participating in a study, this should fade off with time.
- Evaluate a period of use, with a period of non-use, prior to and after the exposure to the system; see for example the evaluation by Oulasvirta et al [9], or for the ASTRA system [11]
- Include explicit checks in your inquiry regarding the possibility of actors adapting their behaviour regarding information disclosure or trust because of the research context (see [14]).

Our own studies have focused on the application of psychometric techniques for the evaluation of these systems, using the ABC questionnaire as above or other questionnaires for evaluating subjective experiences from users. This can give rise to problems during field testing; one cannot keep asking participants to complete the same long questionnaire time and again during a long period of time. The quality of the answers and the compliance should deteriorate. Also, such instruments are not tied to any specific experiences during the evaluation period. What is needed at the moment is improved research methods and instrumentation for evaluating awareness systems during such sustained studies, e.g., using semi-automated diary techniques or experience sampling [4].

5 SOCIAL INTELLIGENCE AND AWARENESS SYSTEMS

By their conception awareness systems are intended as intermediaries in our social relations. They will be embedded in daily social interactions and depending on how well they are designed they might empower or hinder people in their social conduct. How much a system lets someone be perceived as socially intelligent or the opposite is a plausible empirical measure for evaluating awareness systems. This type of evaluation becomes very relevant when an awareness system is partly automated, partially reducing its users flexibility and control regarding how they interact with other individuals. The obvious corollary of this argument is that social intelligence can and should be built into awareness systems that involve some degree of automation. This social intelligence though does not refer to manifesting human like expressions or movements, but to the very understanding of the social implications of the information exchange that an awareness system implements.

Let us examine where the notion of (artificial) intelligence can apply to the operation of an awareness system:

- At the level of capturing and presenting information. An example was the Diarist system which supported interpretation of sensor data and the generation of narrative descriptions in natural language to describe the lower level data in a comprehensible format.
- At the level of disseminating information. At one extreme, an awareness system could manage the flow of information itself, e.g., by attempting to match content to recipients. This can be a hard problem as a system would have to reason regarding the inferences that connected others can draw from information presented to them. For example, when the user's preference for disclosure includes activity but not location, disclosing to others that the user is watching television or conducting DIY may lead them to inferences regarding their location as well.

The second option above represents a major challenge for our ability to reason about social interactions between individuals. A much more likely scenario is that users set their preferences regarding disclosure through an appropriate 'programmable' interface. This will be no minor feat; attempts to automate reachability management or interruption handling have shown in practice to be too rigid and were circumscribed during actual use. Without assuming system autonomy, the mere matching of preferences regarding the entities comprising awareness information needs to rely on a model of awareness information and inferences a human or other recipient could draw from this model. To enable such a possibility a prerequisite is to construct appropriate languages (e.g., XML based) for describing awareness information and for describing the implication relations that connect different types of awareness information (as for example, noted above regarding activity and location). This is the topic of our current investigation in awareness systems and one that could empower users, allowing them to use awareness systems for longer and for facilitating a larger proportion of mediated social interactions.

6 CONCLUSION

This article summarizes the contents of the invited talk to be presented at the Social Intelligence and Design 2007, at Trento, Italy, July 3, 2007. The talk focuses on awareness systems for supporting family communications. These systems have been the topic of our research for some years; related design concepts abound in the literature and a reasonable amount of evaluation studies have been proposed. The first commercial prototypes are making their way to the market. The talk has argued in favor of increasing the level of automation in such systems. The consequence of this is that we need to extend evaluation sessions to long term field trials, and we need to be more critical as a field for how to plan and interpret the results of these evaluations. Technologically, stepping up the level of automation while keeping the user in control requires developing social intelligence, beyond implementing human-like physical behaviors, and onto reasoning that is associated with handling social situations in our daily communication activities.

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