

# FUNCTIONAL VERSUS CONSCIOUS AWARENESS IN CSCW-SYSTEMS

Alex Totter<sup>1</sup> Tom Gross<sup>2</sup> Chris Stary<sup>1</sup>

## *Abstract*

*An increasing number of groupware systems aim at providing users with awareness information—information about the presence, activities, and availability of the other users of the same system. However, most of these systems are designed from a functional rather than a human-oriented point of view. In fact, designers of awareness features more often focus on technical challenges and realisability than on adequate support of group awareness information. In this paper, we relate empirical findings of human behaviour to existing groupware systems identifying requirements for future human oriented groupware systems. When applied from a methodological perspective, this approach leads to the utmost human-centred utilisation of technology to support task accomplishment.*

## **1 Introduction**

The search for a research strategy ‘for evaluating the effect of awareness mechanisms on users and organisations’ [15] has led to the insight that there is a need for the development of a comprehensive and nevertheless detailed concept of awareness. Furthermore, a need for the introduction of methods and measurements to evaluate group-aware collaborative applications has been identified. These issues have been hardly addressed so far. This paper, therefore, does not only revisit potential concepts of group awareness for CSCW systems, but also claims that awareness concepts stemming from social sciences have to be brought to practical use in future collaborative applications.

In order to achieve the integration of the results of empirical studies of human behaviour (in particular, small group research) with technology-driven approaches, we started with an analysis of the concepts of awareness in computer science as well as in social sciences. Based on these findings we have brought these concepts together. This approach has two major advantages: firstly, it enriches the explanation and understanding of awareness for system development and, secondly, it enables a

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<sup>1</sup> Communications Engineering, Department of Business Information Systems, University of Linz, Freistädter Str. 315, 4040 Linz, Austria, office@ce.uni-linz.ac.at

<sup>2</sup> Institute of Applied Computer Science, University of Linz, Altenbergerstr. 69, 4040 Linz, Austria, tom@ifs.uni-linz.ac.at

new generation of artefacts (as part of socio-technical systems) that provide human-oriented awareness features for CSCW systems.

The results of this approach are presented as follows. In the following section we briefly introduce existing groupware systems and their features with respect to awareness. It turns out that existing collaborative applications providing awareness information do not only support awareness incompletely, but also lack consistent support within the single types of awareness. In literature different forms of awareness (stemming from small group research, aviation and social psychology) have been found, which offer explanations and definitions of the terms and concepts used in varying details. We list the results in the subsequent section. In the same section we introduce different forms of operational definitions of the hypothetical construct of awareness—different kinds of human behaviour with respect to awareness.

We then analyse in how far certain features of the examined categories of groupware systems support or enable particular forms of human-oriented awareness and which systems have to be enhanced with behaviour-oriented awareness features. The final section concludes the paper by wrapping up the objectives and the achievements. We also identify areas for further research on mutual adaptation and integration between the social sciences and CSCW—research that we started in this paper and that should become continuous and more accurate.

## **2 Awareness in CSCW and Groupware Systems**

In the last decade while CSCW has emerged as a research field on its own, many groupware systems have been developed. Multifarious taxonomies try to order them according to various kinds of dimensions. Dimensions discussed are time, space, task, sharing, and so forth [c.f. 4, 9, 12]. However, none of these taxonomies uses the provision of group awareness information as an explicit dimension.

The groupware systems providing awareness information are distinguished according to the temporal nature of the cooperation they support (asynchronous, synchronous, semi-synchronous). Asynchronous groupware systems support cooperation at different times; synchronous groupware systems support cooperation at the same time; and semi-synchronous groupware systems apply the notion of place rather than of session or meeting. Table 1 provides the addressed categories of collaborative applications as well as typical instances of artefacts.

**Table 1a. Feature Description of CSCW Systems which focus on Awareness.**

| Classes of group-ware systems providing awareness  | Features to provide group awareness information  | Awareness information provided            |
|--|--|---|
| 1. Asynchronous groupware systems (e.g., Session Capture & Replay System [14])               | Captures users' interactions with any application and storing the data into a session object; capturing of users' actions; key feature: <ul style="list-style-type: none"> <li>replay of users' past actions (what-you-see-now-is-what-I-saw-then, WYSNIWIST)</li> </ul>   | Workspace awareness                       |
| 2. Synchronous collaborative text and graphic editors (e.g., GroupDesign [2])                | Drawing tool for Apple Macintosh computers; was designed for collaboration among a large number of users creating structured graphics; key features: <ul style="list-style-type: none"> <li>manipulated objects marked with busy icon in colour of user</li> <li>graphical and audio notifications about changes ('echo')</li> <li>search other users' positions ('localisation mode')</li> <li>objects have colour of user who created or last modified object ('identification mode')</li> <li>history mechanism</li> </ul>  | Workspace awareness, audio and video echo |
| 3. Synchronous collaborative editors with awareness about actors (e.g., ClearBoard [11])     | Shared drawing medium for two remotely but synchronously collaborating users; key metaphor applied is 'talking through and drawing on a transparent glass window'; key features: <ul style="list-style-type: none"> <li>image of head of drawing partner is overlaid with image of shared artefacts</li> <li>camera focusing on the head of the participants allows the transmission of facial expressions and gestures ('gaze awareness')</li> <li>simultaneous gesturing and drawing</li> </ul>  | Workspace awareness, gaze awareness       |
| 4. Synchronous collaborative virtual environments (e.g., MASSIVE [7])                        | Virtual Reality (VR) conferencing system supporting multimedia communication through audio, video, and text, and supporting partial mediation—that is, users' awareness of others is measured in spatial terms; key features: <ul style="list-style-type: none"> <li>simultaneous meetings can be held at the same time</li> <li>user are embodied as blockies showing their capabilities (e.g., a 'textie' representing users with text terminals)</li> <li>notion of space—distance between users influences media they can use and awareness information they can get from each other and they emit themselves</li> </ul>   | Informal awareness, social awareness      |
| 5. Semi-synchronous virtual office environments (e.g., DIVA [17])                            | Virtual office environments strive to seamlessly integrate various groupware systems into a single virtual environment. Integration concerns functionality of groupware systems like communication, cooperation, and awareness as well as modes of interaction such as real-time cooperation and asynchronous cooperation; key features: <ul style="list-style-type: none"> <li>office model integrates people, documents, and desks for collaboration</li> <li>rooms can be assigned special purposes</li> </ul>  | Informal awareness, workspace awareness   |
| Semi-synchronous event notification systems (e.g.,<br>6. Khronika [13],<br>7. GroupDesk [6]) | Khronika is a system, which increases people's awareness of what is going on around them over time by event browsing and notification in a X11 environment; it receives information about events from various clients, stores it in a database, and delivers notifications about this information to users who are interested in them; key features: <ul style="list-style-type: none"> <li>users then can subscribe to the event types they are interested in ('the recipients are placed in control'); the event demons map a user's personal interests with the data in the database and notify them accordingly</li> <li>depending on access rights to the events, Khronika can provide information about all activities of all users currently logged in and all time and system events</li> <li>GroupDesk provides awareness information about present as well as past activities and about coupled events, which are events that are related to the current activities of a user, as well as uncoupled events, which are events that are not directly related to the current activities of a user but which are of general interest.</li> </ul> | Workspace awareness                       |

**Table 1b. Feature Description of CSCW Systems which focus on Awareness.**

| <b>Classes of group-ware systems providing awareness</b>          | <b>Features to provide group awareness information</b>  | <b>Awareness information provided</b>   |
|---|---|---|
| 8. Semi-synchronous WWW-based systems (e.g., CSCW3 [8])           | <p>Computer-Supported Cooperative World-Wide Web tries to ‘populate’ the Internet—that is, Web pages are considered as rooms, which users enter when they visit a page; users are provided with awareness information about others visiting the same page and can communicate with them; key features:</p> <ul style="list-style-type: none"> <li>• users are provided with information about other users, who visit the same Web page or who recently left the page</li> <li>• users can meet other on Web pages and exchange information and bookmarks</li> <li>• users can chat in IRC-like chat tool and send various kinds of smiley-icons</li> <li>• users can search colleagues logged in on the same CSCW3 server</li> <li>• users can provide their profiles to others</li> <li>• users can annotate Web pages for others</li> <li>• users can navigate jointly through the Internet</li> <li>• users can hide their profile if they want to navigate anonymously</li> </ul> | Informal awareness, workspace awareness |
| 9. Media spaces: constant awareness systems (e.g., Portholes [3]) | <p>Constant awareness systems (also known as whereabouts or availability systems) permanently provide information about presence, activities, and availability of others in virtual space; the goal of the Portholes project was to demonstrate that awareness can be supported across long distances and nevertheless be useful. Digitised video images were sent from Rank Xerox Research Centre in Cambridge, UK, to Xerox PARC in Palo Alto, California and vice versa. Key features:</p> <ul style="list-style-type: none"> <li>• pvc system displays images of others</li> <li>• edison system additionally plays audio sequences</li> <li>• view-master system displays images of public places</li> </ul>   | Informal awareness, social awareness    |
| 10. Media spaces: social browsing systems (e.g., Montage [18])    | <p>Social browsing systems are based on the assumption that a user wants to know if a certain person is present in the virtual space or, more general, who else is present in virtual space; Montage uses a hallway model; key features:</p> <ul style="list-style-type: none"> <li>• hallway model allows users to navigate virtual hallways and glance into others’ offices; glances give a good impression if the user is in her office and if she currently wants to be approached</li> <li>• if the doorway is open, the cruising person can peek in; peeking is reciprocal—that is, a person who is monitored can also see the observer</li> <li>• users can put signs on their door saying that they are available, busy, and so forth</li> <li>• from this reciprocal glances, full-featured desktop video conferences can be started immediately</li> </ul>  | Informal awareness                      |

### 3 Understanding of Awareness in Social Sciences

After we have completed the review of the state of the art in the development of groupware and CSCW-systems we proceed with the results of our in-depth literature review in social science. The findings comprise possible concepts of awareness as well as a variety of operational definitions—that is, human behaviours reflecting one or more of the identified concepts. In this section we provide a compilation of concepts and assign human behaviours to the identified categories of awareness. Empirical studies of human behaviour have revealed several understandings and explanations of awareness (cf. Table 2).

All the forms of awareness we introduced have been empirically tested (cf. respective papers). With the exception of objective self-awareness, it has been found that awareness significantly influences the performance of work tasks, and, in case of proper enactment and support significantly reduces human errors and increases the accuracy of work results (cf. respective papers). Hence, human-centred design does not only require a focus on group awareness as featured by groupware systems but also the consideration of different forms of awareness stemming from social sciences. Different operational definitions of the hypothetical constructs of awareness have been found. In Table 2 eighteen characteristic forms of awareness—that is, forms of human behaviour—are presented.

**Table 2. Definitions of Various Kinds of Awareness.**

| <b>Type of awareness</b> | <b>Definition</b>   |
|--------------------------|---|
| Group awareness          | <p>A specific set of behaviours as characteristic of intimate, primary groups [1, p. 82f]:</p> <ol style="list-style-type: none"> <li>1. affective behaviours in the form of (verbal and non-verbal) expressions of emotions: a) positive sentiments (rewards), b) negative sentiments (punishment), c) general affect (neither rewards nor punishment)</li> <li>2. collective orientations: primary group members experience a sense of interdependence with one another, and a mutual welfare in a joint venture</li> <li>3. particularism: is an act in which a given individual orients towards another on the basis of other's possessions of properties (i.e., qualities or performances), which bear a distinct relation to the actor's own properties (i.e., traits or statuses)</li> <li>4. diffuseness: behavioural occurrences of diffuseness are typified by an actor's display for broad interest in another</li> </ol>  |
| Social awareness         | <p>Eight social awareness forms [16, p. 321]:</p> <ol style="list-style-type: none"> <li>1. awareness of one's own experience from the self: I'm feeling angry</li> <li>2. awareness of one's experience from the perspective of another person: She's reacting as if I'm angry—maybe I am</li> <li>3. awareness of the other's experience from the self perspective: She has no right to be so mad.</li> <li>4. awareness of another's experience from that person's perspective: I'd be furious if I were here, too</li> <li>5. awareness of one's own appearance from the self perspective: scrutinising ourselves in a mirror.</li> <li>6. awareness of one's own appearance from another's perspective: suddenly noticing someone is observing us</li> <li>7. awareness of another's appearance from our own perspective: Why doesn't he comb his hair?</li> <li>8. awareness of another's appearance from that person's perspective: we notice that a teenager seems obsessed with her complexion.</li> </ol> |
| Task specific awareness  | <p>Task specific awareness of the working process [5, p. 251] can be demonstrated by the</p> <ol style="list-style-type: none"> <li>1. adequate description of the used strategies (consciously monitoring and regulating this strategies), and</li> <li>2. by detailed reports on the difficulties in understanding the task</li> </ol>  |
| Situation awareness      | <p>The three level development of situation awareness [10, p. 2395f]:</p> <ol style="list-style-type: none"> <li>1. Level 1 concerns the operator's ability to perceive elements in the current situation.</li> <li>2. Level 2 situation awareness integrates information concerning the current process state derived at Level 1 into overall comprehension of the current situation.</li> <li>3. Level 3 situation awareness concerns the projection of the current process state into the near future. The importance of this future projection is that the operator must assess now if the anticipated future process state is perceived as disparate with operational goals and plan mitigating actions accordingly</li> </ol>   |
| Objective self awareness | <p>Changes in performance may occur subsequently because of an increased motivation to reduce the intrapersonal discrepancies. The individual's performance can suffer, if the individual spends too much energy in the current process of self-attention, because he/she does not have enough resources to accomplish her task.</p>  |

## 4 Revisiting Awareness

Given the results of the previous sections—capturing both the recent developments in CSCW and the findings of empirical research—we proceed according to the objectives of our study. The objectives were:

1. to evaluate existing groupware systems in how far they enable or support different forms of awareness from a human behaviour perspective
2. to identify those deficiencies of existing groupware systems that have to be overcome to support human-oriented awareness

In order to achieve this shift from technology-driven development towards human-centred design of socio-technical systems we have specified a scheme for comparing technology-driven approaches to a behaviour-oriented understanding of awareness. Such a scheme does not only enable the interpretation of existing technical features as enablers of different types of human behaviour in the context of awareness, but also the check whether the enabled human behaviour corresponds to the empirical findings, and furthermore, the identification of required improvements of existing collaborative applications to foster the development of human-oriented socio-technical systems.

In Table 3 the results of the steps addressed have been summarised. The instances of groupware systems featuring awareness as listed in Table 1 have been put into the context of human behaviours as presented in Table 2. The capability of the sample systems and their degree of support have been (re-)rated with respect to the awareness behaviours. The entries in Table 3 reflect the results at a glance. We have marked the capability of a system to enable or support a particular form of awareness with 'X' at the corresponding cross cell.

Our results in Table 3 show that the groupware systems only support a limited number of human behaviour in a very broad scattering. 'Collective orientation', an aspect of group awareness, 'awareness of another's appearance from our own perspective' (social awareness) and 'the operator's ability to perceive elements in the current situation' (situation awareness) are those forms of human behaviour that are primarily supported. ClearBoard, Diva and CSCW3 provide most of the characteristics, namely ten out of eighteen forms of human behaviour. Social awareness is supported in systems like CSCW3 and through emoticons such as ;-). These emoticons represent social attitudes as well as personal feelings about certain topics or persons. They can be placed anywhere along textual information. However, the use of these symbols does not seem to have established certain social understandings or standards among user communities. One form of task awareness, the 'adequate description of the used strategies' can only be achieved implicitly, whereas particularism remains still unsupported. Three out of eight forms of social awareness and 'the projection of the

current process state into the near future' (situation awareness) has not been implemented as particular features as well. Finally, non of the investigated groupware systems supports all aspects of one kind of awareness.

**Table 3. Groupware Systems in the Context of Human Behaviour-Oriented Categories of Awareness**

| Groupware Systems   | 1  | 2  | 3                  | 4   | 5  | 6  | 7 | 8  | 9    | 10   |
|---|----|----|--------------------|-----|----|----|---|----|------|------|
| Featuring Awareness<br>Forms of Conscious Awareness                     |    |    |                    |     |    |    |   |    |      |      |
| <b>Group Awareness</b>  |    |    |                    |     |    |    |   |    |      |      |
| 1. affective behaviours   |    |    | X                  | X   | X  |    |   | X  | X    |      |
| 2. collective orientations  |    | X  | X                  |     | X  |    |   | X  | X    | X    |
| 3. particularism  |    |    |                    |     |    |    |   |    |      |      |
| 4. diffuseness  |    |    |                    | X   | X  |    |   | X  | X    |      |
| <b>Social Awareness</b>   |    |    |                    |     |    |    |   |    |      |      |
| 1. awareness of one's own experience from the self                      |    |    |                    |     |    |    |   | X  |      | X    |
| 2. awareness of one's experience from the perspective of another person |    |    | X                  |     |    |    |   |    |      |      |
| 3. awareness of the other's experience from the self perspective        |    |    | X                  |     | X  |    |   |    |      |      |
| 4. awareness of another's experience from that person's perspective     |    |    | X                  |     | X  |    |   |    | X    | X    |
| 5. awareness of one's own appearance from the self perspective          |    |    |                    |     |    |    |   | X  |      |      |
| 6. awareness of one's own appearance from another's perspective         |    |    |                    |     |    |    |   |    |      |      |
| 7. awareness of another's appearance from our own perspective           |    |    | X                  | X   | X  |    |   | X  | X    | X    |
| 8. awareness of another's appearance from that persons perspective      |    |    |                    |     |    |    |   |    |      |      |
| <b>Task specific awareness</b>  |    |    |                    |     |    |    |   |    |      |      |
| 1. adequate description of the used strategies                          | X* | X* | X*                 |     | X* | X* | X | X* |      |      |
| 2. detailed reports on the difficulties in understanding the task       | X  |    | X                  |     | X  |    |   | X  |      |      |
| <b>Situation Awareness</b>  |    |    |                    |     |    |    |   |    |      |      |
| 1. the operator's ability to perceive elements in the current situation |    | X  | X                  | X** | X  | X  |   | X  |      |      |
| 2. overall comprehension of the current situation                       | X  | X  |                    |     | X  | X  |   | X  |      |      |
| 3. projection of the current process state into the near future         |    |    |                    |     |    |    |   |    |      |      |
| <b>Objective Self Awareness</b>   |    |    |                    |     |    |    |   |    |      |      |
|   |    | X  | X<br>fea-<br>sible |     |    |    |   |    | X*** | X*** |

\* implicitly

\*\* limited to the actor's environment

\*\*\* monitored person

In order to provide the entire spectrum of a particular kind of awareness, several improvements are required from a technical perspective. For instance, the Session Capture and Replay System only provides an implicit description of the used strategies for awareness. Visualisations like bar charts and flow diagrams could help users in being aware of the used strategies.

The ClearBoard system got best ratings concerning social awareness. However, it does not provide users with information about their own appearance (points 5 and 8 in Table 3) and it does not provide information about the effect(s) of the own appearance to other users. Overview diagrams providing users with miniature overviews of the entire collaborative setting (including both actors and their actions) could improve social awareness information support of ClearBoard.

All technical features have to take into account the social dimension that actually has to be addressed for the forms of awareness to be enabled or supported. Due to space limits we can only give an example for group awareness. For instance, none of the existing groupware systems supports particularism. However, support for particularism is a very important criterion for effective group work—it is essential to form a transactive memory system. A transactive memory system is a ‘set of individual memory systems in combination with the communication that takes place between individuals’ and is ‘more than its individual component systems’ [19]. ‘The individual gains other’s domains of expertise, of course, but also gains access to the knowledge that is created through integration within the transactive memory. [...] Moreover, a group with a smoothly functioning transactive memory is likely to be effective in reaching its goals and will thereby satisfy its members.’ [ibid., p. 197]. The accountancy of the social-, since behaviour-oriented dimension of awareness has to be considered as a prerequisite for implementing human-centred design specifications. However, current description or specification languages are not capable to reflect this dimension to transform semantic knowledge to syntax structures.

## **5 Conclusions**

Based on the results of the latest discussions of awareness with respect to collaborative applications we have developed and followed a research agenda towards embedding empirical findings concerning awareness into CSCW-system development. The multi-step procedure involved the review of existing technical features as well as the structuring of results in social sciences (studies concerning human behaviour). As such, the demand for interdisciplinary research in the field of CSCW has been met and finally led to requirement definitions for artefact development.

The epistemological analyses in this paper clearly reveal that existing groupware systems only partially support behaviour-centred awareness, and that some important kinds of behaviour are not supported at all (cf. Table 3). Further investigations are required. They are primarily concerning methodological issues.

First of all, the designers should be aware of what kind of awareness their systems should support according to the classification of awareness stemming from social sciences. Following the traditional



classifications proposed by CSCW researchers will lead to a continuous neglecting of empirical results (i.e., the social realities users of collaborative applications are part of). On the long run, the resulting methodological and conceptual diversification of social sciences and CSCW will be continued—a process that does not facilitate, but rather hinder the integration of previously isolated fields.

Secondly, it is necessary to enrich the existing groupware systems with the identified features. This way, holistic support of the type of awareness they aim at becomes feasible. However, the results of these improvements have to undergo critical review: Empirical evaluations of the group performance achieved through the novel mix of features for the different types of awareness are required. Following this procedure, novel behaviours might be recognised that in turn lead to novel features, and so forth.

According to this concept, a truly interdisciplinary discourse can be established, since it does not only lay ground for novel conceptual and methodological inputs for CSCW and the social sciences, but also brings benefits in terms of synergistic effects for group members. The latter has to be considered as a prerequisite towards human-centred system design.

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