Web-Browsing on Stage: Using the Theatre of Work for Awareness on the WWW

Tom Gross, Wolfgang Prinz
GMD—German National Research Center for Information Technology
FIT—Institute for Applied IT
Schloss Birlinghoven
53754 St. Augustin, Germany
+49 2241 14 2091
{tom.gross, wolfgang.prinz}@gmd.de

ABSTRACT
In many situations users can benefit from group awareness—information about remote users' presence, availability, activities and other information about the remote environment. In this paper we present the Theatre of Work Enabling Relationships (TOWER) awareness environment. We particularly focus on the presentation of the awareness information in a 3D world and on mobile devices. Furthermore, we introduce awareness contexts for structuring awareness information and exemplify their use in a WWW context.

1 INTRODUCTION

In the CSCW literature it has been emphasised for years that efficient and effective cooperation requires that the cooperating individuals have information about other users' presence, availability, and actions as well as about shared artefacts, and so forth [4, 8]. This information is often referred to as awareness or group awareness [2, 5].

In situations where the cooperating individuals are at the same place this information is obvious and can be gathered easily. In other situations where the users are geographically dispersed technological support is essential.

We present a generic extendible awareness environment, which includes simple but powerful mechanisms for the generation and user configurable presentation of awareness information. The information is captured and presented in a context-sensitive way—that is, both the context of origin of an event and the current work context of the user are taken into account. In this paper we mainly focus on the presentation of awareness on the 3D stage and on a mobile client. We will introduce the TOWER awareness environment. We will then show the presentation of the awareness information on the 3D world and on ambient interfaces. And we will describe how awareness contexts are used to structure awareness information. Finally, a scenario will demonstrate how TOWER can be used for providing awareness on the WWW.

2 THE THEATRE OF WORK ENABLING RELATIONSHIPS—TOWER

The TOWER system aims at bringing the wealth of clues and information that create awareness and cohesion in co-located teams to the world of virtual teams and to present them in a Theatre of Work. This information is important for the mutual orientation in cooperative work processes but also for the social interaction. Organisations are more and more restructured around virtual teams. Thus 'they loose opportunities for innovation through the causal sharing of knowledge and learning induced by physical proximity' [14] or as Prusak [13] describes this phenomenon vividly: 'If the water cooler was a font of useful knowledge in the traditional firm, what constitutes a virtual one?'

TOWER aims at supporting group awareness and chance encounters through a 3D environment that is at the heart of the Theatre of Work. Avatars and symbolic actions represent users and their current actions on shared objects while using a groupware application. Avatars of users who work in a similar context appear spatially close in the 3D environment. The Avatars perform symbolic actions that illustrate events in an information space, episodes of interaction or non-verbal behaviour.

We believe that the provision of such a service is vital for the successful cooperation and knowledge sharing within distributed teams that use the WWW and other Internet applications as the preliminary cooperation platform.

The TOWER system is composed of a number of interworking components. Figure 1 illustrates the overall TOWER architecture.

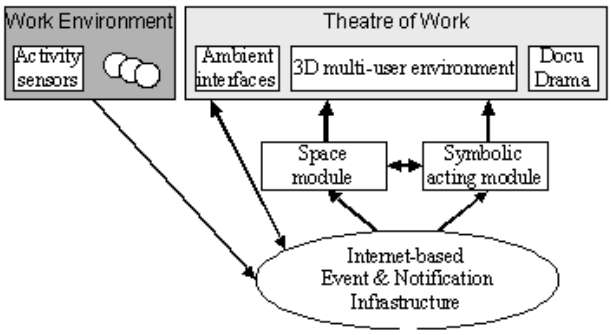

Figure 1. Illustration of the TOWER architecture.

It consists of:

- A number of different activity sensors that capture and recognise user activities in a real and virtual work environment and that submit appropriate events.
- An Internet-based event & notification infrastructure that receives events and forwards these events to interested and authorised users.
- A space module that dynamically creates 3D spaces from virtual information environments (e.g., shared information workspaces such as Lotus Notes) and that adopts existing spaces to the actual usage and work behaviour of the users that populate these spaces.

- A symbolic acting module that transforms event notifications about user actions into symbolic actions, i.e. animated gestures of the avatars that represent users and their activities in the environment.
- A 3D multi-user environment that interoperates with the symbolic acting and space module for visualisation and interaction.
- The 3D visualisation is complemented by ambient interfaces integrated into the physical workplace providing activity visualisation beyond the standard desktop.
- A DocuDrama component that transforms sequences of event notifications and history information into a narrative of the past cooperative activities.

The primary goal of TOWER is the presentation of activities in a cooperative environment through symbolic acting in the Theatre of Work. This requires an event and notification infrastructure that is capable of recognising and sensoring user activities on shared objects or in a shared environment [12]. TOWER includes an infrastructure that is fully integrated with the Internet. This infrastructure provides a number of sensors that can be integrated with user applications using Internet protocols such as HTTP, which are available in almost all standard application nowadays. In addition, agent-like sensors are realised that observe information sources and the population of information by users. All sensors submit events that encapsulate activity information to the infrastructure.

Tasks of the infrastructure are to store, aggregate, and forward the activity information to applications that have registered interest in the appropriate information. For the interaction with other applications push and pull methods are realised. Methods are developed to ensure restricted access to activity information access rights, and to provide reciprocity for ensuring transparency between producers and consumers of information.

3 THE TOWER STAGE AND PRAVTA

The information in TOWER is presented on the TOWER stage in the 3D world, and on Ambient Interfaces in the physical environment of the user and in a WAP interface.

3.1 The TOWER 3D Multi-User Environment

The 3D virtual environment represents the stage set within which symbolic acting and all other TOWER interactions take place. This stage set is built by the space module and populated by the symbolic acting module. Both are described in the following.

The space module dynamically creates 3D spaces from virtual information environments (Figure 2). These spaces evolve in response to the patterns of space use, (e.g. web page use and behaviour by those who are using them). In this sense the TOWER environment will develop a record of its own past history, which will in time act as a powerful asynchronous device, which will help users find their way and find each other. It serves to structure people and information according to classifications based on the conceptual distance between their interests and contents. The spatial structure of the built environment affects movement patterns by creating more and less strategic routes. In turn people take advantage of these patterns of 'passing trade' to locate themselves and facilities [11].

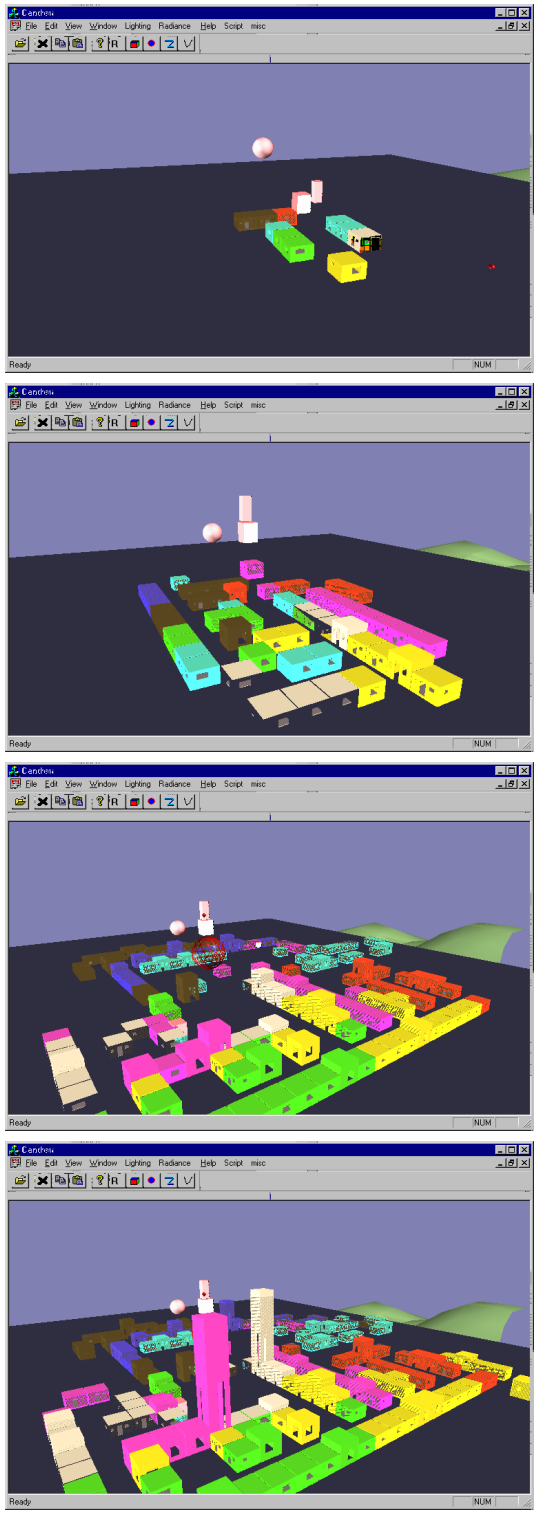

Figure 2. The prototype TOWER world showing growth and rearrangement during the creation process [6].

The space module can be seen as providing the means by which the setting for symbolic acting will itself carry and constitute meaning. In this sense behaviour patterns within TOWER are 'situated' whether these are determined by the overt behaviour of the users or by the semi-autonomous processes of symbolic acting.

Fostering simple effective communication is vital to collaborative working, the emergence of flexible working and the growing attraction of post-geographical working inevitably introduce distortion into key messages,

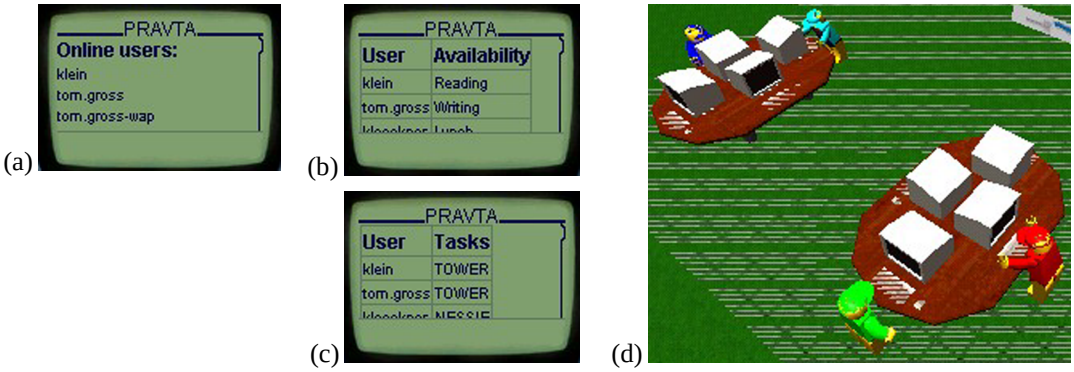

Figure 3. Screenshots of the presentation of awareness information in the PRAVTA prototype.

dissonance between groups and adds additional cognitive effort to even the simplest interaction. Symbolic acting is a concept where the useful information of 'who is doing what' is displayed visually for the benefit of everyone without adding cognitive effort to the users [9].

The idea of symbolic acting is to automatically detect what the user is up to and use this to control what their avatar does. An avatar acts out the symbolic meaning of the users everyday actions on their behalf. The emphasis in symbolic acting is to show the contextual information telling us about where a user is, who they are and what they are doing right now. By taking away the responsibility for controlling the avatar from the user and automating it we remove the problem of relying on neglect prone manual controls to add life to a world. With symbolic acting the context dependent actions of all users can be shown at all times so the world can seem like a more active place as well as more closely reflecting the activities of a user group. We let the system do the walking – and the acting. This is a very powerful and engaging way of solving problems in mediated communication.

3.2 The Ambient Interfaces and PRAVTA

The Ambient Interfaces of TOWER currently include several physical indicators such as lamps that can be switched on and off, a fish tank in which babbles can be released and plastic fish can be moved, ambient sounds that can be played, and a client for mobile devices. In the following, we will particularly focus on the client for mobile devices.

PRAVTA (PResence Availability Task Awareness) is a lightweight and mobile supplement to the 3D world and the other ambient interfaces that are very powerful and highly personalisable, but stationary. In fact, it allows users to actively query various types of awareness information, to enter und update awareness information about themselves, and to spontaneously contact other users anytime and anywhere. Being based on WAP [15], the PRAVTA prototype can be accessed from any mobile device that supports WAP such as mobile phones with integrated GSM modems, WAP stack, and micro-browser (e.g., Nokia 7110); palmtops connected to mobile phones with micro-browsers (e.g., Ericsson MC218); and smartphones (e.g., Nokia Communicator).

The PRAVTA prototype is implemented on two layers: the PRAVTA Client that realises the user interface and the PRAVTA Communication Layer. The user interface at the PRAVTA Client is implemented in the wireless markup language (WML). WML is a tag-based browsing language that supports screen management with text and images; data input such as text or selection lists; and hyperlinks and navigation support. It is, therefore, well suited as a platform for user interface design for mobile and ubiquitous applications. The wireless application protocol connects the user interface to the PRAVTA communication layer. The PRAVTA Communication Layer translates the data from the TOWER server into PRAVTA format (i.e., WML and WMLScript) and translates the data from the PRAVTA client into TOWER format. It provides mechanisms for login and access control, and so forth.

After the users have authentified they can query information about the presence of other users resulting in a table with all online users. They can check the availability of others and get a table with the current availability. Figure 3 shows screenshots of the result of 'Who is online?', 'Check availability', and 'Check tasks' as well as the actual state in the 3D world.

For users who are in their everyday work environment the TOWER sensors can capture information about their presence, availability, activities, and so forth. As PRAVTA can be used in any surrounding, the user has the possibility to manually update their status. Figure 4 shows screenshots of the dialogue for changing the availability and the task status as well as the corresponding updates in the 3D multi-user environment.

So far, we have mainly focused on mechanisms for the

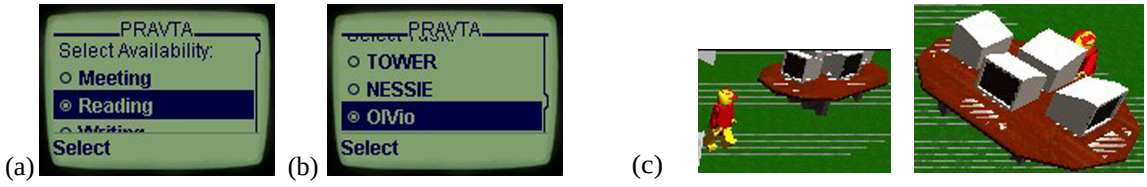

Figure 4. Screenshots of the specification of awareness information in the PRAVTA prototype.

presentation of awareness information in TOWER. It is additionally important that the system captures and presents appropriate information; this is realised with awareness contexts.

4 AWARENESS IN CONTEXT

In this section we introduce awareness contexts to structure awareness information according to users, artefacts, and tools as well as actions and events. Awareness contexts can emerge in various dimensions: geographical contexts and locations such as buildings, floors, offices; organisational contexts such as departments or projects, but also clubs, where people are members of; personal and social contexts like family, close friends; technological contexts such as users of specific technologies (e.g., ICQ); action or task contexts such as users who perform similar actions or tasks with similar tools; and so forth [7].

In general, an awareness context can be defined as 'the interrelated conditions in which something exists or occurs' [10]. In our concept contexts are described by a set of attributes (cf. Table I).

Attribute	Description
context-name	Name of the context
context-admin	Human or non-human actor who created the context
context-member	Human members of a context
context-location	Physical locations related to a context
context-artefact	Artefacts of a context
context-app	Applications related to a context
context-event	Events relevant to a context
context-acl	Access control list of a context
context-env	Related contexts

Table I. Awareness context attributes. These attributes allow the matching of events to contexts of origin and the detection of the current work context of the user.

They are described subsequently:

- Each awareness context has a unique name.
- The administrator of a context is the person who created and manages the context.
- Members of a context are all users who work in a context and who consequently produce events through their actions.
- Locations, at which events can be produced are either electronic (e.g., a shared workspace) or physical areas (e.g., a meeting room).
- The artefacts of a context are all objects on which users can operate.
- Each context is associated with various single-use and cooperative applications (e.g., text editors, programming environments, groupware applications).
- Events that are produced in a context are described by their types.
- An access control list for an awareness context comprises a list with all the rights that exist for each context; each member of an awareness context may have the right to produce events, to subscribe to events or event types, and to decide how she wants the events to be presented. Context-specific ACLs guarantee that the members of a context are informed about the events within the context, but that privacy is kept concerning users who are not members of the context.
- Each awareness context has various connections to its environment and to other contexts (e.g., two projects with one awareness context respectively, which have overlapping membership). Big contexts consisting of many members, many shared artefacts might be spread over several locations and might be organised in sub-contexts [1].

A context description does not require the specification of all attributes. For instance, a context can be created and some attributes like locations or applications are specified only later on; or a context could have no locations or no applications at all. Nevertheless, the more details are available for a context, the better events can be matched to the context. In many cases the attributes of a context can be generated automatically. For instance, if a context consists of a shared workspace the list of members and artefacts of the context can be dynamically gained from information about the shared workspace.

The application of awareness contexts in TOWER follows the following procedure. First, the system analyses the context of origin of an event and adds context information to it before it is stored in the server. Secondly, the system analyses the current context of work of the user who needs to be informed—this can derived from his recent actions. Thirdly, when the system knows the context of work of the respective user it checks his user preferences and notifies him accordingly.

After we have presented these general ideas about awareness contexts and their application, we will now show how awareness contexts are applied in TOWER.

5 SCENARIO: THE WEB AS A CONTEXT

TOWER can easily be used for supporting awareness on the WWW. Benford et al. [3] presented a similar approach, where they also use a 3D representation of users and data. For this purpose, users specify the context of origin, the work context, and their preferences. A context of origin contains a specification of all relevant events and event attributes. The context-member attribute contains a list of relevant users. The context-location attribute contains a list of relevant Web sites and pages. The context-artefact contains a list of relevant documents that are shared on the Web (e.g., in the BSCW shared global workspace). The context-app attribute contains a list of relevant applications such as Web browsers, chat tools available, and so forth. The context-event attribute contains a list of event-types that are relevant (e.g., read events, update events). The context-acl specifies the users that have access to the context. Finally, the context-env attribute contains a list of related contexts (e.g., a project related to the Web sites and pages of this context). In the work context the user describes the situation in which she wants to be informed; it is described similar to the context of origin.

In the preferences the user can specify for each work context about which context of origin she wants to be informed. Furthermore, the user can specify the timing of the notification: immediately (an event is presented when

it is captured); date or rhythm (at a defined time and date or in specific intervals); and age of the event (especially when no other timing is specified).

As these specifications can become quite complex over time the TOWER systems allows users to share the specifications. For this purpose, the specifications of contexts of origin, work contexts, and preferences are stored in a shared workspace system. The TOWER client then takes these shared specifications. This mechanism can also be used to implement reciprocity of awareness—that is, the users of a context shared the specifications and are therefore mutually aware of each other and each other's actions.

When the users have specified their contexts and their preferences they can use the system for Web browsing. The Web pages that are relevant for the contexts are displayed in the TOWER world (cf. Figure 2). Each building represents a Web page. The clustering of the buildings in the TOWER world represents the actual use of Web pages—that is, pages that are used in the same context are group close to each other. The height of the buildings indicates the number of accesses to the respective Web page. The avatars (cf. Figure 3) are moved in the TOWER world according to their movements on the Web. In contrast to many other collaborative virtual environments the TOWER users do not actively navigate the TOWER world—they are navigated by the system. The TOWER world can then be used for orientation: Web users can easily see from the TOWER world which documents are semantically related, which documents are accessed most, where the Web users are, and so forth. Although the system does the navigation of the avatars, social encounters are nevertheless possible: users get notifications if their avatar passes the avatar of another user.

6 CONCLUSIONS

In this paper we have introduced the Theatre of Work Enabling Relationships including its general architecture and its presentation of awareness information in the 3D world as well as in the lightweight PRAVTA client. We have introduced the notion of awareness contexts, and described their application in TOWER. Finally, we have exemplified the use of awareness contexts for the Web.

7 ACKNOWLEDGEMENTS

The TOWER system is being developed in the IST-10846 project TOWER, partly funded by the EC. We would like to thank all our colleagues from the TOWER team.

REFERENCES

1. Agostini, A., De Michelis, G., Grasso, M.A., Prinz, W. and Syri, A. Contexts, Work Processes, and Workspaces. *Computer Supported Cooperative Work: The Journal of Collaborative Computing 5*, 2-3 (1996). pp. 223-250.
2. Begole, J., Rosson, M.B. and Shaffer, C.A. Flexible Collaboration Transparency: Supporting Worker Independence in Replicated Application-Sharing Systems. *ACM Transactions on Computer-Human Interaction 6*, 6 (June 1999). pp. 95-132.
3. Benford, S., Snowdon, D.N., Brown, C.C., Reynard, G.T. and Ingram, R.J. Visualising and Populating the Web: Collaborative Virtual Environments for Browsing, Searching and Inhabiting Webspace. In *8th Joint European Networking Conference* (May 12-15, Edinburgh, UK). 1997.
4. Dourish, P. and Belotti, V. Awareness and Coordination in Shared Workspaces. In *Proceedings of the Conference on Computer-Supported Cooperative Work - CSCW'92* (Oct. 31-Nov. 4, Toronto, Canada). ACM, N.Y., 1992. pp. 107-114.
5. Erickson, T., Smith, D.N., Kellogg, W.A., Laff, M. and Richards, J.T. Socially Translucent Systems: Social Proxies, Persistent Conversation, and the Design of Babble. In *Proceedings of the Conference on Human Factors in Computing Systems - CHI'99* (May 15-20, Philadelphia, PE). ACM, 1999. pp. 72 -79.
6. Gavin, L., Mottram, C., Penn, A. and Kueppers, S. *Space Module.* Report Number: TOWER Devliverable D3.1, 2000.
7. Gross, T. and Prinz, W. Gruppenwahrnehmung im Kontext. In *Verteiltes Arbeiten - Arbeit der Zukunft, Tagungsband der Deutschen Computer Supported Cooperative Work Tagung - DCSCW 2000* (Sept. 11-13, Munich, Germany). Teubner, Stuttgart, 2000. pp. 115-126.
8. Gutwin, C., Roseman, M. and Greenberg, S. A Usability Study of Awareness Widgets in a Shared Workspace Groupware System. In *Proceedings of the ACM 1996 Conference on Computer-Supported Cooperative Work - CSCW'96* (Nov. 16-20, Boston, MA). ACM, N.Y., 1996. pp. 258-267.
9. McGrath, A. The Forum. *ACM SIGGROUP Bulletin 19*, 3 (1998). pp. 21-24.
10. Merriam-Webster Incorporated. *WWWebster Dictionary*. http://www.m-w.com/dictionary, 1999. (Accessed 6/7/1999).
11. Penn, A., Desyllas, J. and Vaughan, L. The Space of Innovation: Interaction and Communication in the Work Environment. *Environment and Planning 26* (1999). pp. 193-218.
12. Prinz, W. NESSIE: An Awareness Environment for Cooperative Settings. In *Proceedings of the Sitxth European Conference on Computer-Supported Cooperative Work - ECSCW'99* (Sept. 12-16, Copenhagen, Denmark). Kluwer Academic Publishers, Dortrecht, NL, 1999. pp. 391-410.
13. Prusak, L. *Knowledge in Organisations.* Butterworth-Heinemann, Oxford, UK, 1997.
14. Swan, J., Newell, S., Scarbrough, H. and Hislop, D. Knowledge Management and Innovation: Networks and Networking. *Journal of Knowledge Managment 3*, 4 (1999). pp. 262-275.
15. WAP Forum. *Wireless Application Protocol Forum Ltd.* http://www.wapforum.org/, 2000. (Accessed 21/11/2000).