Theatre of Work:
Time Design for Distributed Workgroups

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ABSTRACT
In this paper we describe the Theatre of Work Enabling Relationships (TOWER) environment, which provides an infrastructure for awareness support. We then discuss how it can be used to orchestrating distributed users by giving a shared framework for orientation.

INTRODUCTION
In the CSCW literature it has been emphasised for years that efficient and effective cooperation requires that the cooperating individuals are well informed about their partners' activities [5]. This mutual knowledge about each other and about the shared environment is an important prerequisite for shared orientation of co-workers providing a frame of reference, in which they can perform their individual tasks in accordance with the overall group process. They require information about the other persons they are cooperating with, about their actions, about shared artefacts, and so forth. This information is often referred to as awareness (sometimes with prepositions such as *group* awareness [2, 6] or *workspace* awareness [12].

In situations where the cooperating individuals are at the same place this information is often perceived automatically [13]. Here the shared place often serves a basis for allowing various different forms of interaction among users, and the flexible changing between them. For instance, users can work on a problem together synchronously, but they can also easily split up the task, work individually, and reunion later. The fact that they are at the same place gives them flexible ways of checking back at each other's offices to have a look if the other person has already finished or might need some help. This flexible pacing of cooperative endeavours is somehow missing in situations where individuals, who are at different places, cooperate as a group. Here, technological support for the flexible pacing of the cooperation process as well as the perception of cooperative activities is essential.

The types of awareness that are supported by technology today range from informal awareness about other people (or presence and availability awareness; or shared awareness [4]; or general awareness [8]) to workspace awareness about shared artefacts [12].

In the earliest attempts the information was captured and presented within one single application (e.g., [1, 14]). This first generation can be called *proprietary awareness systems*—they allow flexible coordination of activities, yet only in a single application. In the second generation toolkits were developed that contained components for presenting awareness information. These *awareness widget toolkits* made the development of applications easier, because the software developers did not have to implement their awareness widgets from scratch (e.g., [17]). In the third generation, *awareness information environments* allowed capturing information from various applications and other sources and presented the information in a generic representation such as with tickertapes of pop-up windows on the computer desktop (e.g., [7, 15]). These awareness information environments go beyond single applications and, consequently, provide more flexible pacing for long-term cooperation spanning several different forms of cooperation and single-user as well as cooperative applications.

In this paper we describe the Theatre of Work Enabling Relationships (TOWER) environment, which provides an infrastructure for awareness support as a means to orchestrate geographically distributed users in long-term cooperative endeavours spanning a broad range of interaction. We present a brief overview of the system and mainly focus on the TowerWorld—a 3D world representing shared artefacts, and users working with them. We then discuss how TOWER and the TowerWorld can be used for flexible pacing of work in distributed workgroups.

THEATRE OF WORK
The Theatre of Work Enabling Relationships (TOWER) environment aims to support distributed work groups or virtual communities with group awareness in their current work context. It provides an infrastructure for facilitating chance encounters and spontaneous conversations among remote users.

For this purpose, the infrastructure has various sensors capturing information about users and their activities and a range of indicators notifying users about the presence, availability, and current activities and tasks of the other users. *Sensors* capture user activities within the TOWER environment (e.g., logins, logouts), user activities on Win* platforms (e.g., changes to files, sharing of folders and files, starting of applications, opening of documents), user activities in shared workspaces (e.g., a sensor for the Basic Support for Cooperative Work (BSCW) system [3] records all activities in the shared workspaces such as user logins and logouts, folder creation, invitations users to shared folders, document uploads), access to Web servers. A broad variety of *indicators* present the awareness information. Examples are lightweight indicators such as pop-up windows with pure text or tickertapes displaying messages about the other users and shared artefacts; AwarenessMaps, which provide awareness information in

the context of shared workspaces; the TowerWorld, which presents shared artefacts and users in a 3D multi-user environment; ambient interfaces, which present the information in the physical environment of the users; and mobile client presenting light-weight information for users on the road.

In this paper we will only have space for briefly describing the TowerWorld. Information on TOWER as a whole can be found in [16]; information on the ambient interfaces can be found in [9] and other indicators can be found in [11].

The *TowerWorld* is a 3D multi-user world; it consists of a stage that is dynamically created based on shared information space such as BSCW workspaces [3] or the content of other document management systems and avatars navigating on this stage and performing symbolic actions. Figure 1 shows screenshots of a TowerWorld: the first picture presents a view from the distance, where users can get a good overview of the whole stage with all its cubicles representing the documents; and the second picture shows a close-up of the same TowerWorld with more details (e.g., icons representing the file types, avatars positioned according to the current activities of the respective users).
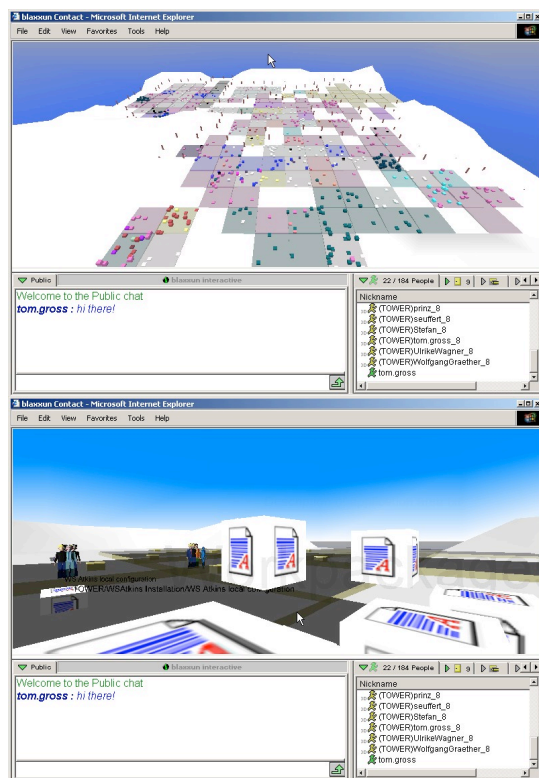

Figure 1. TowerWorld: (a) overview from a distance; (b) details in a close-up.

The stage evolves in response to the patterns of use in the shared information space. The stage is generated and adapted according to rules and semantic mappings that can be specified by the users. Various attributes of the documents in the shared information space can be visualised such as the type of a document, the size of a document, the frequency of manipulations to a document, the creator of a document, the similarity among documents, and so forth. These attributes can be mapped to the size of the cubicles in the TowerWorld, their shape,

their colour, their position, their clustering, and so forth. Another criterion for the stage creation is the granularity of the mapping of document sets into the stage. User workshops yielded different opinions whether a more detailed view or a more abstract overview provides better context for the visualisation of user activities. In the current implementation users can select between different worlds, each created by different selection criteria and rules for generation and mapping. In an overview world for example objects in the TowerWorld represent only folders of the shared information space, while the detailed TowerWorld provides a representation for each document. In the overview world activity spots are easier to recognise while in the detailed world clusters of objects with a similar semantic are easier to identified.

The stage of the TowerWorld is populated with avatars representing users and representing their current activities as symbolic actions such as automatic navigation through the TowerWorld and gestures. The emphasis in symbolic acting is to show the contextual information telling users about where the other users are, who they are and what they are doing right now. With symbolic acting the context dependent actions of all users are 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.

DISCUSSION

The TOWER environment it its current state provides a broad range of sensors capturing information, a variety of indicators presenting the information, and convenient means for specifying preferences.

Its particular strength lies in the modelling of awareness contexts and the entailed possibility for flexible adaptation of the information to the respective user, situation, and task. The TOWER environment allows users to specify their personal preferences with respect to the information they want to receive, with respect to the indicators used for the presentation of this information, and with respect to the timing of the presentation. A light-weight, but powerful, context model allows to structure the captured events into semantically coherent aggregations that make more sense to the users and abstract from, sometimes unwanted, details [10]. At the origin of events they are analysed and mapped to awareness contexts. Likewise, the events a user produces are analysed and mapped to a context. Now, the user can specify for each context which kind of information they want to receive, and how it should be presented. Furthermore, they can specify their preferences concerning the timing: they can opt for immediate presentation, for presentation in rhythms (e.g., once per hour, once per day), or particular moments (e.g., upon login, before logout). In order to facilitate the specification of the preferences and in order to allow for better co-orientation among users, the TOWER environment provides functionality for sharing preferences. That is, users can publish their preferences in shared workspaces, and other users can then subscribe to them.

So, on a whole the TOWER environment and, and particularly the TowerWorld, capture various events that are happening in a geographically distributed workgroup.

With the help of the context models the environment then tries to construct a coherent 3D world, which represents all important aspects of the real world. This 3D world serves as a stage or a representation of the real world, making users aware of what is going on in the real world. Through positioning and animating each individual participant, this 3D world provides users with both awareness about their cooperative environment with other users, their actions, and shared artefacts, but also self-awareness about how their own activities fit into the overall group situation. This way, the TowerWorld not only is a descriptive representation, but also has some normative influence on the users and fosters their mutual pacing.

In this workshop I would like to discuss various aspects of time and design, and would like to contribute our experience with the design, development, and evaluation of the TOWER environment.

BIOGRAPHICAL INFORMATION

Tom Gross recently joined the Faculty of Media of the Bauhaus-University Weimar, Germany, as associate professor for CSCW. Before that, he was a senior researcher at the Fraunhofer Institute for Applied Information Technology FIT. His research interests include computer-supported cooperative work, human-computer interaction, and global information systems. He holds a diploma and a doctorate degree in Applied Computer Science from the Johannes Kepler University Linz, Austria.

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