Group Awareness: Where, What and with Whom – in Search of Taxonomy for Cooperative Visualization Tools

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Abstract: This paper presents a simple classification for selected visualization tools meant for cooperative settings. The main division is made by dividing the tools into two classes, namely document and user –oriented and then pondering the qualities of the example tools against this framework. On the basis of the taxonomy, we found that attention should be paid to the following properties when developing visualizing tools: orientation, analysis features and how to choose data to be visualized.

Introduction

Visibility, transparency and awareness of different types are among the criteria needed to foster cooperativity and to improve the conditions for more productive group-work in virtual systems. One means to enhance these qualities is to use visualization. How visualization is implemented, however, varies greatly among the tools available. *First*, pure *social presence* can be indicated visually, e.g. by showing the location of a user, his or her online status or co-presence in the same virtual space synchronously. *Secondly*, the presence can be indicated asynchronously by referring to the usage/work history of the users and then representing this graphically, e.g. by using color-gradient to show the number of visits in case of documents, by using annotations (comments and highlightings) to show the 'read wear' or by indicating the time spent in the system. The common nominator for these 'read wear' type of tools is to make knowledge regarding to the activities more transparent and usable for the users. Thus it provides *content & knowledge oriented viewpoint* for the system visualization and focuses on the interaction between the human and the mediating knowledge artefact. *Thirdly*, it is possible to visualize the real animate interactions between the users: with whom the interactions are taken and about what they are concerning. This provides *interaction oriented viewpoint* to the tool-design. This provides three-layer framework to visualization, as presented in Figure 1.

Social presence (I level) is inherently present in all tools that are meant to foster group learning or working. The mode of social presence can be synchronous or asynchronous, and it is often described using social navigation (SN), a prequisite condition of which is to make the activities and movements of other users visible. The decision making, navigation and validation of information may get easier, and as Hill et al. (1992) say, the best thing in SN is, that it is a free by-product of our interactions. The purpose of visualization is then to make these dynamic footsteps visible and build paths for users to follow. Whatever the task domain is, awareness information is needed to coordinate the activities among users in shared information spaces, as Dourish and Bellotti (1992) said as early as in 1992.

In this paper we shall present a simple classification for selected visualization tools that support group work or learning. The main division is made according to the orientation of visualization in the tools, namely (1) document oriented or (2) user oriented, as proposed by Nikula and Sutinen (2004). Document oriented focus on visualization of the content, the objects and products of activities (level II, in Figure 1), and user oriented tools can be described focusing on visualization of user interactions – the conversational patterns between users (level III, in Figure 1). Both types of visualization are needed: when we interact with each other we have some mediating artefacts to work with, and when

we work with documents, comment or co-author something, it is an advantage to see and know the patterns of communication and the co-presence of others. The main strand of this work is to zoom what is visualized, and whether the tools can be reduced into the two classes proposed.

The outline of this paper is as follows: first we shall describe a set of selected example tools and systems that provide visualization in group contexts. Next we shall summarize the common features and orientation of the tools in form of tables, which form a preliminary classification and is intended to serve as a small taxonomy. Last we shall draw conclusions, summarize the findings and propose next step to be taken – the future of taxonomy for visualization tools.

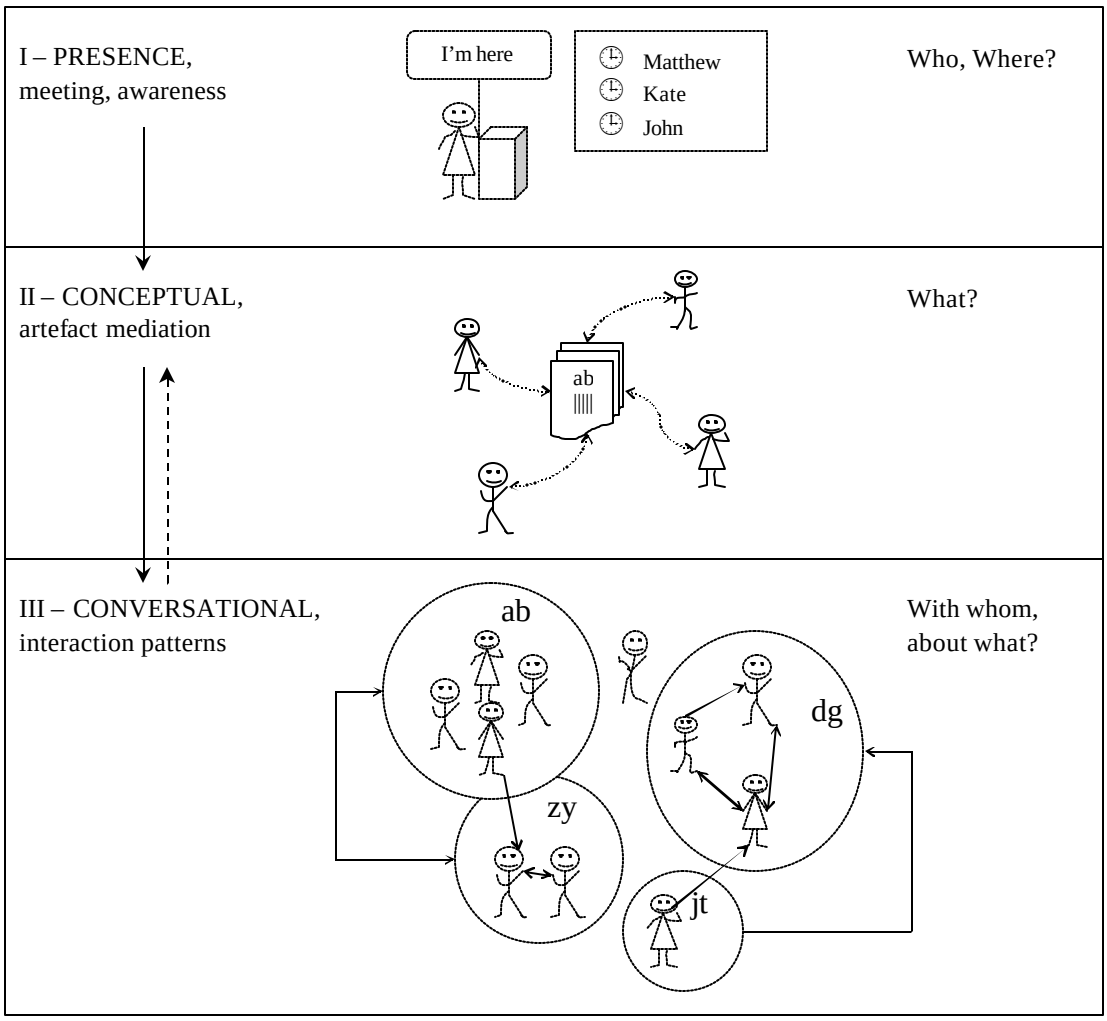

Figure 1: Three levels of visualization in cooperative systems.

Example tools classified

The authors have selected a set of divergent visualizing tools to create a small taxonomy out of them. The common feature for all subjectively chosen tools is to vizualize cooperative activities. Whether the starting point is to visualize relations between the users or between the users and the documents is one main classification criterium used. For example Grocevi (Nikula & Sutinen 2004) clearly describes the interdependencies between the users based on e-mail conversations in graphical format, while the tool like that of Minard and Donath's (1999) visualizes only the traffic on web-pages, the visits. Next we shall demonstrate briefly all the selected tools, and summarize their properties and criteria for taxonomy in the Tables 1 & 2 that follow.

Visualizing tools
EDUCO

EDUCO is a cooperative learning environment (CLE) that supports synchronous social navigation so that the student is aware of the activities of other students in the system (Miettinen et al. 2002). In EDUCO all course-related documents and the real-time traffic around them are visualized using Java applet and the 'social proxy'. The color-grade of the document indicates how many times it has been examined. Furthermore the users are represented as dots in the system's view and thus made available for discussions via chat. This is, however, optional with a connotation that if a student does not want to be seen, s/he cannot see others either. EDUCO has been developed in the cooperation of the Helsinki University of Technology and University of Helsinki (HIIT).

EDUCOSM

EDUCOSM (Miettinen et al. 2003) is a cooperative learning environment (CLE) which makes both direct and indirect social navigation possible. In EDUCOSM the direct asynchronic social navigation refers to a social navigation on the basis of the history (read wear) – in a "past" sense, but it is reciprocal, i.e. allows commenting and replies. EDUCOSM supports student centered learning, i.e. allows students to take more control on their own learning – both as individuals and in form of groups (peer-activity), and offers more knowledge creation oriented stance towards learning. In EDUCOSM learners can bring material to the environment and annotate (comment and highlight) it. Annotations and their maker are visible to all. This supports the transparency of learning process. There is also a discussion area (threaded discussion) in the system. The user's activities in the system are directed on the basis of her/his profile.

Fle3, Future Learning Environment

Fle3 has been designed and developed at the Media Lab in the University of Art and Design Helsinki (Leinonen et al. 2002). It is a web-based learning environment, which supports the collaborative learning. Fle3 directs the user to create information and to direct and reflect his/her learning process together with the teacher and the group. Fle3 is based on five principles: the self-direction, the inquiry learning, the interaction in the group, the meta-cognition and support by the teacher.

Fle3 offers tools for the selecting, collecting, analyzing, explaining and building the knowledge and for the transmitting the information to others. The most central tool is a discussion map, which supports the building of the shared communal knowledge. Other tools build around the map are for example a desktop, Jamming - tool which supports the collaborative brainstorming, a common calendar, the message system and index of the users.

VisualWho

VisualWho (Donath 1995) is a tool for the visualization of complex relations, where the object being visualized has certain predefined properties. The purpose of the program creators has been to use VisualWho to visualize social connections so that the users could – by examining and understanding the roles, ideas and use history – to understand why they belong to a certain subset in the community. VisualWho can be used to visualize the presence or belonging to some group.

Visualizing the Crowds at a Web Site

Nelson Minard and Judith Donath (in MIT) have developed a tool which can be used to visualize crowds of people visiting a web site (Minar & Donath 1999). The view is composed from the web page describing icons (squares) and icons which describe users (circles). The icons, which describe web pages, are drawn according to which category they have been placed in. For example the research sites can be drawn with blue and the course information pages with yellow. One page icon can represent either one page or the site of for example one research group. The icon, which describes the page, is drawn the stronger colour the more active the site in question is visited. The colour of the users' icon is determined by the user's web address. The view is real-time and with the tool it is possible to animate the moving of users from site to another.

Grocevi

Grocevi is a tool developed in the University of Joensuu (Nikula & Sutinen 2004) for the visualization of group processes. Grocevi makes the evaluation of the quality of the interaction possible. With the help of the tool user can estimate whether the opinions are only small talk or a part of the genuine discussion. It is assumed that the conversations led in the peripheria of the maintopics do not constitute real, quality discussions and thus lack the 'quality' in case of the prevailing context. With the Grocevi user can also estimate whether the users have functioned as a group in the discussion or have formed smaller, independent discussion networks. With the tool it is possible to visualize the discussion activity and interaction graphically. Furthermore, the tool makes the follow-up of the development of the interaction possible. This way the real-time information about the students' ways to communicate with each other and about their communication styles is obtained.

Woven Stories 2

Woven Stories 2 (Nuutinen et al. 2004) is a tool which supports collaborative writing and the idea generation. With this tool several users are able to see the documents in a form of concept map. The final output can be for example a document which has got many different endings. In Woven Stories 2 the document does not need to be written or does not need to be read in a linear form, but the users can go through the document how they want to. Woven Stories 2 is based on the idea of the collaborative writing demonstrated by Harviainen (Harviainen et al. 1999). The prototype has been developed in the Department of the Computer Science of the University of Joensuu.

CoFIND

CoFIND (Collaborative Filter in N Dimensions) is a web based collaborative self-organizing resource database which supports the cooperation (Dron 2002). The tool has been developed in the University of Brighton. Purpose of the CoFIND is to help to find essential information from large information masses. The idea of the system is to arrange and to recommend the material of different subject matters for example on the basis of how the material has been read, have been commented on, and have been judged. CoFIND uses a self-organizing principle known as a stigmergy for the classification of the material. Any user has a possibility to bring material to the database and to create subjects and subject groups.

Knowledge Sea II

Knowledge Sea II (Brusilovsky 2004) – developed in the university of Pittsburgh – is a web-based educational system using social adaptive navigation support (SANS), where the activity of the users in case of the documents is filtered and visually presented to show the overall page-traffic and the difference between user and general (group-based) navigational behavior. The personalization mechanisms in use are content-based- and collaborative filtering. The first checks the content (word) level information, while the latter falls into the domain of social navigation techniques and utilizes the user-history of the documents. A student can so reflect his or her activity against that of the others (the class) and see the total navigation in all different subject-areas of the course. One of the main reasons for the system, besides its educational impacts, is to research how an open-corpus related navigation support could be evolved.

Babble

Babble (Erickson et al. 1999) is a light-weight tool designed to make social information visible, i.e. to support productive conversations among members in small groups both textually and by graphical means. The system was developed in the Loops –project (IBM Watson Research Center), the name of which describes the semantics of the system: to keep users aware of what is going on. The concept of social translucense covers the ideas of awareness and accountability: by making the activities and knowledge visible also the carrying on the dialogs may become easier in CMC –systems. In Babble the user can see the stored conversations as persistent documents, comments laid in sequential order (asynchronous mode). Synchronous means used is *social proxy*, a graphical representation of users and their conversational activity. The conversations are shown as circles and the users as colored dots. The participation of some conversation puts user inside the discussion-circle, while the other users (visible dots) outside the rings are online, but not engaging any conversations. The most active participators are placed in the centre of the social proxy, and those not attending much, are in the outer-regions. The system further presents the online status of the users as well as the list of topics (the conversations). The conversations are lead by chat-based manner and oriented by the topics.

CENTERS

CENTERS (CollaborativE Informal InTERaction System) (Contreras-Castillo et al. 2004) is a system that allows students and teachers to interact and communicate with each other via chat and instant messages – spontaneuously and "on-need" -style. It supports informal synchronous interactions related to course material on hand; it shows where the users are and what they are doing in the online learning environment. Direct social navigation utilizes URLs as marks and all the communication uses HTTP-protocol. CENTERS-server functions as a mediator of communication, contains a repository, provides the presense awareness and directs contacts and messages. Users are shown in a listlike –manner besides the material under reading and thus made available for the "in-situ" communication by graphical means.

ACTIVEMAP

ACTIVEMAP (McCarthy and Meidel 1999) is a visualization tool designed for working environments: to improve the conditions for cooperation. It focuses on the visualisazion of users' location information and is intended to provide better opportuniteis for face-to-face contacts in the workplace. ACTIVEMAP uses ArialWiew Awareness Systems (a tracking system with infrared sensors and radio frequencies) and by this means locates the users and shows them real-time on the computer-screen, "on the map" of the working environment. The users are represented by their framed-

pictures and the visual cues from the "freshness" of the presence is shown using image- and frame shading. The map-view is zoomable and equipped with tooltips. The groups of people are represented either as stacks or tiled on the locations. Audio messages are possible to be used (inputted textually) and the user has some control over his/her visibility, the underlying timing scale.

EFOL/Kalas

EFOL (European Food On-Line) (Svensson et al. 2001) is an on-line food shopping system in Internet, where users can affect the content of the recipe collections, see the presence of other users and interact with help of chat –function. EFOL is a recommender system that provides suggestions based on the recipe selection behavior of other users. It thus uses both direct and indirect social navigation. It groups the recipes into the collections that function as meeting places for users. Furthermore it visually shows into what group(s) the user belongs and what groups there exist. Human intervention is needed to keep up with the dynamicity of the recipe collections and user preferences, even if a filtering algorithm provides help in the process.

ReachOut

ReachOut (Ribak et al. 2002) is a tool designed to be used in organizational settings. It is a chat-based tool for collaboration and community building. It combines the best features from newsgroups and chat complemented by topic awareness and enhanced percistence of discussions. ReachOut uses various CSCW related techniques behind its design, like newsgroups, bulletin boards, recommender systems and instant messaging (IM). Human mind is considered as a powerful information retrieval system, and the philosophy of 'turn to other people and ask' wells from this. Each question constitutes a chat room, which are kept open for a bit longer time to make participation possible also later on. The targets of visualization are (1) questions (annotated, log-marked, user controllable colors, state), (2) awareness (visual gauges with 2-dimensions: units and the order of magnitude) and (3) buttons (for navigation support, profile filling). Furthermore there is question pushing as animated fading in and out messages, status of the question marked and chat shows also the past message history, not only the on-going conversation.

Taxonomy

System	Target of visualization	Analysis features	Supplementary functions
EDUCO	the activity around/within the documents in the learning environment	-	chat, notification when selected user logging in or selected document is opened for reading, zoom
EDUCOSM	annotations (comments and highlightings in the documents)	-	discussion forum
Fle3, Jamming	how the ideas and documents are developi	planning process can be animated	general learning environment tools, chat, calendar
VisualWho	users are related to the group	history of the presence can be visualized	-
Visualizing the Crowds at the Web Site	utilization of web pages	history of the usage activity can be visualized	-
Grocevi	interaction between users	development of the interaction can be visualized, any users discussion partners can be emphasized	-
Woven Stories 2	how the ideas and documents are developi	-	chat
CoFIND	inquiring of documents	-	-
Knowledge Sea II	the traffic of individual and groups in context of learning materials (documents)	the activity of the learner related to the group	-
Babble	comments, social proxy (conversational activity and presence of users)	-	social proxy, persistent sequent conversations
CENTERS	presence of users in same course-related webpage	-	informal, spontaneous interactions, chat + IM
ACTIVEMAP	the dynamic location of users in the worki place ("map with faces")	-	audio contact, badges, zoom
EFOL	the user-groups, recipe collections and	-	chat, filters and ranking

	individual users in them		
ReachOut	questions, topics and their stateof the art	status of the questions, persistency of chat	IM, storage, meeting center

Table 1: Target of visualization and analysis features of the ex. tools

System	**Target domain (E/W/L)** **E=education, W=work, L=leisure**	**Orientation** **D=document, U=user**
EDUCO	E	D
EDUCOSM	E	D
Fle3, Jamming	E	D
VisualWho	W	U
Visualizing the Crowds at the Web Site	W	D
Grocevi	E	U
Woven Stories 2	E	D
CoFIND	E	D
Knowledge Sea II	E	D
Babble	W	D
CENTERS	E	D
ACTIVEMAP	W	U
EFOL	L	D
ReachOut	E/W	D

Table 2: Domain and orientation of the ex. tools

Discussion

When acquainting with different visualizing tools, the duality of the different tools rose distinctly forth. It was easy to distribute the tools on the basis of the fact, whether they were used for the visualization of documents or persons. On the basis of this division, we distributed the visualizing tools to the ones, which are document oriented and those that are user oriented. It was also possible to perceive another clear duality in the purpose of the use, namely educational vs. work. Unexpectedly all visualizing tools used two-dimensional visualizing and the third dimension had not been utilized. On the other hand, this may be a better solution from the usability point of view, because the users of different systems can be very heterogeneous. Chat was the most general of the peripheral services of the systems.

On the basis of the taxonomy, attention should be paid to the following properties when developing visualizing tools.

- Orientation
- Analysis properties
- How to choose the data to be visualized

Orientation

The user should be able to change the orientation [of visualization tool], if needed. The division to the document oriented and user oriented functions well, but a possibility to change the point of view offers clear advantage compared to the present systems. For example, if the system offers information both about the documents read by the users (example EDUCO) and the users' communication patterns (example Grocevi), the system could visualize the groupings of users on the basis of the documents read or the relations between the users – show the points of common interest. In addition to this, if set operations could be applied to these groups, the documents interesting a group could be found.

Analyzing Properties

Results of the visualization or groups to be visualized can be analyzed with the present tools mainly using animation. One tool (Fle3) provides the opportunity to compare two separate planning processes side by side with help of animation. It should be, however, possible to compare the results otherwise than merely visually, for example performance of logical set operations with groups would make a discovery of cliques possible in a more effective way than at the moment. These [cliques] could, later on, be represented visually in various ways and equipped with extra information when necessary.

How to Choose the Data to Visualize

In the present visualizing tools the user cannot influence what information is brought up and visualized; the systems have been built to visualize certain closed set of features decided beforehand. More flexible system implementation would bring many advantages compared to the present systems. The system could, for example, propose or visualize itself some other information based on earlier visualization of the users, and thus indicate features of adaptation; the system could bring up or visualize those users that had discussed among themselves and read the documents, which are related to a certain subject or then the system could propose a topic for a selected group of people based on their previous areas of interests. By raising the level of awareness – by means of this preliminary taxonomy for visualization – it is easier in the future both for the users and the implementators to select the tool and the features needed. In addition, it gives visualization a clearer focus, makes it more meaningful and sharpens the features that do have some practical purpose. Whether and what really is needed, however, can and ought to be studied more with animate users, based on their preferences, to make the interaction between users, i.e. the cooperation, easier. After all, it is group awareness, not group fuzziness, we aim to increase.

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