

An Empirical Study of Awareness in Web Based Cooperative Writing Applications

Aslam Muhammad¹, Muhammad Yasir², Martinez Enriquez A. M.³, G. Escalada-Imaz⁴

^{1,2}Department of CS & E, U. E. T. Lahore, Pakistan

³Department of CS, CINVESTAV-IPN, D.F. Mexico

⁴Artificial Intelligence Research Institute, IIIA-CSIC, Spain

¹maslam@uet.edu.pk, ²yasir.muhammad1983@gmail.com, ³ammartic@cinvesta.mx, ⁴gonzalo@iia.csic.es

Abstract: As part of any groupware that supports people achieving a common goal, it is required to provide information about structured shared objects and the activities of participants, as well as an efficient communication service and effective coordination mechanism. Thus, this paper presents an empirical study of the trade-off concerning awareness functionality with in fifteenth well know cooperative writing applications (CWAs), evaluated on the basis of present and past awareness elements, these applications are classified taking into account time and work place parameters.

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1. Introduction

Current computer technologies like network communication made possible the cooperative work in a distributed way, independent of geographical location of hardware resources, software, and presence of users. In addition to study and understand the working of computer technology like engineering disciplines, it is also essential to comprehend how people use a groupware application when they produce whether individually or in group (social and cognitive sciences). Both domains give roots to the Computer Supported Cooperative Work (CSCW). This kind of work is related to the technology whose goal is to support groups of people collaborating to reach a common goal or perform a common task [15].

An infrastructure that supports a group of people to carry out shared tasks to achieve a common goal is named a groupware [6] like instant messenger, email service, or cooperative writing applications. A groupware considers issues like how people can produce in group (social aspect), how to share available resources like working memory, storage media, including hardware (computer support).

Analyzing groupware applications based on data collection techniques, software development cycle, and conclusion drawn for their evaluation [3], it is realized two main characteristics of a groupware [15]: a) the synchronous vs. asynchronous interaction mode, for instance conferencing vs. email, b) the remote versus co-located processing nature, for instance

meeting rooms, and argumentation system. Despite of synchronous/asynchronous execution mode, a groupware should provide information about user activities and status of common production [10]. This knowledge is provided by means of group awareness functionality, whether integrated into the groupware application or developed separately to be plugged into it. Awareness concerns with present and past actions executed by group members on commonly produced objects, providing a way to communicate and coordinate user activities [13].

In [15], a survey that evaluates about 45 papers from ACM CSCW conferences. These papers are analyzed in five aspects: data collection techniques, software development cycle and conclusion drawn from the evaluation. Almost one-third of the analyzed groupware system were not evaluated in a formal way and only about one-quarter of the articles includes evaluation in real world and wide variety of evaluation techniques are available. This survey concluded that there should be some new techniques for the evaluation of groupware which should be simple and low in cost.

The hypothesis of an empirical study on collaborative writing [14] is that people use collaborative writing editors only if they are sure that their partners also use the same. Thus, an inquiry placed on WWW and related to the use of collaborative editors, was filled out by 41 persons. This inquiry analyzes "How people work when they write a document in a collaborative way? What kind of tools do they use? In particular, do they resort to groupware for this task?" etc. As a

result of this inquiry, it seems that people like a word processor instead of using specialized collaborative writing. New communication technologies such as chat as instant messaging are hardly to be used. They are more familiar with email, face-to-face meetings, and telephone (Section 3). People give highlighted importance to functions like tracking, version control, and synchronous work. Section 4 describes our study of CWAs based on present and past awareness elements. Section 5 draws conclusions.

2. Group Awareness

Cooperative Writing Application, CWA offers an environment support to users working in group, like individual/group editing, uploading/downloading productions, and annotation. In addition, awareness, communication service, and coordination mechanism are also incorporated. The hardware part comprises input/output resources including, shared catalogs and primary/secondary storage.

There are two major types for viewing a groupware [6]. The first one is based on the combination of time-space variables: - same place and time like decision support systems; - different place but on same time e.g. video conferencing, games; - same place but different time e.g. shared office systems; and - different place and time e.g. email services. The second type irrespective of location work, based only on execution time, a groupware can be synchronous or asynchronous. In real time, changes are visible to all group members when each participant allows his/her changes to others. It means users produce at the same time a common document and they receive or view the updated content of the production from other coauthors. For instance, REDUCE [16]. In asynchronous groupware, users produce and upload their production on a designated document storage site. Later, this production is available to his/her colleagues. For instance, BSCW [1] and EquiText [2].

No matter, a CWA application is synchronous or asynchronous, distributed or centralized; it should provide awareness information to users working in groups.

Awareness elements: Awareness concerns with “*an understanding of the activities of others, which provides a context for your own activity*” [12]. Information from the workspace comprises awareness elements related to present and past user activities, realized within the workspace (see Table 1).

The present awareness elements are [7]:

- **Who** element like presence, showing who is currently in the workspace? Identity or authorship of original idea.
- **What** element includes actions, information about executed operation, intention (what is the outcome of a particular operation), artifact (on which object a user is working).
- **Where** element involves location where user are working, gaze (where are users looking?), view (where can a user see?), reach (where can a user reach?).

The past elements are divided into five categories:

- **How** element indicates action history (how did an operation happen?), history (how did this object come to be in this state?).
- **When** shows event history (when did an event occur?).
- **Who** demonstrates presence history (who was present and at what time?).
- **Where** present location history (where was a user during a particular time?).
- **What** includes action history (what has a user been doing?).

On the basis of above elements, awareness can be:

- Workspace awareness concerns with all elements [7],
- Presence awareness provides who (past and present) information [13],
- Situation awareness deals with who, how, and where [12],
- Contextual awareness integrates where element [4],
- Action awareness gives information about how, when, and what elements [6].

To better collaborate, group members require a communication service to exchange their view points, as well as an efficient coordination mechanism to resolve conflicts, after having information either about user activities, product evolution, or artifacts.

3. Communication and Coordination

Normally, users at different physical locations need to share their ideas using a communication service, the second important issue in cooperative work. Group communication started from the development of Delphi method, allowing communication about complex problems among experts. Emergency Management Information System and Reference Index (EMISARI) derived from Delphi Conference System which is used for monitoring purposes from long time. The Delphi systems are famous for their features such as quantitative communication structures, content and

indirect based communication, roles, and notification. Computer-mediated Communication (CMC) uses capabilities of computer network, processing, and storage to support communication within group [9].

In recent times, several communication modes are available: message posting, chat, conferencing, email. Instant messaging (IM) is a quasi synchronous communication, convenient for discussing activities irrespective of location work. Recently, IM provides facility of video and voice conferencing, along with awareness functionality like users status, management of members of different groups (friends, co-workers, ...). User presence could be a constraint, because not all the time, participants are able to establish a chat session, due to different time zones, variable office/lab working hours, and other social/professional engagements.

Email is also a popular asynchronous mode of communication. An email message is composed of two major sections: header and body. Coordination of users activities could be a major issue in email communication since group members have to exchange so many long textual messages and concerned users have to wait until recipient responds is comprehensible. Absence of context could also be the cause of exchange of long text messages.

Short Messaging Service (SMS) is an asynchronous communication, used for mobile devices like cell phones and PDAs. Initially, SMS supported simple textual communication sending short messages to group members. Recently, audio and video information is also sent from mobile to mobile, web to mobile, and mobile to web. The limited size display and the messages size are the main limitations of SMS messaging. The use of unknown abbreviations may be another restriction.

The implementation of an appropriated kind of communication is guided by the work domain and the groupware application. For instance, instant or SMS messaging are suitable for mobile device whereas emails for office/lab works.

Working in group implies many constraints: limited resources available, changes in roles, priorities of task, user interests, management of dependencies among user activities to share resources, and perform effectively the collaborative/cooperative work. The support of these constraints gives rise to the coordination. In the context of CSCW, the coordination is defined as "*the support for the activity of managing dependencies and possible conflicts between collaborative entities (users and their roles) involved in common and inter-related tasks of a*

collaborative activity (actions performed in the shared workspace)" [8].

We explore CWAs in order to investigate the kind of awareness integrated, the way group members communicate, and mechanism they coordinate their activities.

4. Awareness in Cooperative Writing Applications

CWA is accessed through web browser over network. Normally, a web application is built using standard HTML/XHTML format [17]. In such case, data from server is downloaded into browser buffer and then displayed on the user screen allowing users to interact with server or with other clients thus, any modification in the shared resource on server side is easily reflected on the client side. Three types of architecture are used in developing CWA [11]: a) Centralized architecture allows collaborators to store and process data on central server, b) Fully distributed architecture copies all components and shared resources on the different site servers so that each provide same functionality, and c) Hybrid architecture replicates processing component on the local sites and shared data on the central server. To perform any action on hybrid architecture, first collaborators download data from the central server and introduce the lock feature to avoid inconsistent/incoherent shared production, modify it locally, and upload it on central server, and unlock the data.

Following, we describe the working/architecture of each studied CWA, and then evaluate its awareness system, communication service, and coordination mechanism.

4.1 Basic Support for Cooperative Work (BSCW).

BSCW [1] built on centralized architecture, supports either synchronous cooperation, providing tools for planning and organizing meetings, or in asynchronous mode, providing shared workspace for storing, managing, jointly editing, and sharing information.

BSCW functionality are related to personal objects: trash option to prevent unauthorized/unintentional deletion of objects, address book to invite members to join workspace, calendar helps to manage appointments, bookmark option to provide quick and easy access objects, task list to be carry out, briefcase option to synchronize documents from local computer to the workspace, adding option to upload documents, discussion option to propose ideas.

In addition, BSCW provides - view and reach by viewing user's role, - action and event history is launched by clicking 'history' option

(presence and location history information) (see Table 1), the last activity performed by user on a particular location of the workspace is indicated by color-code; - monitor option provides information about authorship, action, intention, and artifact; - identity (who are the participants and their roles in a particular activity) is provided by clicking on the shared icon.

The communication among users depends upon server configuration: - instant messaging, - SMS when users mobile phone numbers are included in address book, or - computer conferencing when users are currently running on the same computer conferencing program (see Table 2).

The BSCW users coordinate their activities through set lock and freeze option in the workspace. An owner can temporarily locks a document, so it cannot be modified or replaced by other one and a lock-icon appears on the shared object. When a document is frozen, it cannot be modified until it is unfrozen by owner or by the system administrator. The freezing document is also shown with the same icon.

4.2. Equitext

Equitext[2] is an centralized asynchronous collaborative writing editor. Two options are offered: start a new activity or work on the existing one. To create a new theme, users contact the administrator, who gives them a password to access a theme or create a new one. Users can select from already registered texts to contribute.

Information about when a collaborator has performed operations on a particular object is provided by clicking on the record option. Event, presence, and action history by viewing date and time of any performed operation or comment on an object. Artifact history is provided through partial draft option (see Figure 1).

When collaborators implicitly exchange their point of view by making comments on a paragraph, an asterisk appears against it. Users cannot coordinate their activities in Equitext. Minor change in architecture of product (software) can imply major modification in task dependencies and when these changes do not reflect towards collaborators, who are coordinating the product development, cause severe consequences, such as diverting from the modified goal.

4.3. Thinkfree

Thinkfree [18] is asynchronous web and desktop based cooperative writing editor built on

hybrid architecture. Users can also work on offline mode. The offline file manager keeps track of local files present on the computer. When Internet is available, collaborators can synchronize all documents that were modified during offline mode with the respective online version stored on the Thinkfree Web Server. Thinkfree manager is used by users who use desktop version.

Users are able to create projects and sends invitation through email service to other members to join the project. Online storage facility called MyOffice. Event history is provided about tasks, issue, or comment made by collaborators. Actions history information is limited to make comments. Presence history is achieved on limited scale from event history, who collaborator was present and when (past).

After naming and describing a new task, it is possible to include the email of all users who join the project. A message is send to concerned users when creator selects the notification action. Thus, communication is done through email notification and by posting comments. In Thinkfree, there is no way to coordinate collaborators activities, implying possible redundant results and inconsistent document production.

4.4 Writely.

It [19] built on hybrid architecture. It is quasi-based synchronous web based writing editor as updates itself after two minutes. The word document, presentation, or spread sheet is published on the web browser. The file organizer is very simple, provides a very usable interface for uploading, downloading, and creating new files in any of the suite's three applications. Users can produce while they are disconnected, and then synchronize their changes automatically when they are reconnected.

Writely provides information about identity through user name list, authorship through owner, viewer, and collaborator fields. Information about action, artifact, event, presence, and action history comes through 'revision function' of the last two revisions, displayed on three columns: - revision column specifies an integer which is the revision number, - last edited column displays the time of the revision and the author, - changes column describes the modification, date, and time.

Users who want to share a document with other collaborator send an invitation by email, the service is available when any shared document is opened in the workspace.

Shows that comments available to that topic

Shows alter operation applied to text

Shows insert applied to topic

Shows operations which can apply to text

#	Conteúdo do Parágrafo	Colaborador	Ações	Out	Data
1ª	Isso é um teste teste conjunto	er12	A		13/07/2009. 09:16
2ª	Como ter permissão para ser proponente?	amatta	I		06/07/2009. 10:00
3ª	Não aparece a opção inserir novo tema	ritadet	I		28/07/2009. 21:14
4ª	Alem de entrar no texto e inserir assunto, palavras, nao entendi como utilizar. Ja li o Faq mas nao sei como criar um assunto.	cmleao	A		03/07/2009. 11:29
5ª	a construção colaborativa define a pedagogia moderna	ritadet	I		03/07/2009. 10:16
6ª	Tem que baixar algum programa chamado equitext para poder utilizá-lo?	leticia1	I		20/06/2009. 17:05
7ª	Olá Pessoal, o Equitext além de permitir alterarmos os textos construídos em colaboração, permite, também, o incentivo a autonomia na escola. Esta autonomia pode ser legitimada tanto na formação continuada de professores quanto na formação dos estudantes. O Equitext é uma ferramenta que utilizarei tanto na formação continuada de professores quanto no processo de aprendizagem dos estudantes. O foco da formação docente prevê a integração das tecnologias digitais e telemáticas nos projetos de aprendizagem aqui em Sinop- região norte do Estado de Mato Grosso. Abaixo a todos.	alima	A		08/06/2009. 00:26

Figure-1. Awareness elements in EquiText

4.5 Project & Course Forum.

Course Forum is an asynchronous web based writing editor used for remote learning [20] and Project Forum a multiple project in office [21], whose architecture are centralized. Course makes instructor contact, course information, and lectures on which student could make comments at any stage and post assignments on them. Teacher and students can interact conveniently to create posts and share/discuss course content. Project Forum makes meeting notices, to-do list, provides information about group members, share, discuss, and review ideas.

The awareness in Course and Project forum constitutes with information about the identity of the group member who posts comments and event history (who and how elements). If at the time of posting comments, they are authoring, the author identification is always displayed. The document displays the date of the last modification (when element). On every page of Course/Project Forum there is a box for writing and posting comments, the authorship is optional. While a page is locked, users clicking on the lock option, a password is asked to enter who is allowed to post comments. This is a way to coordinate user's activities.

4.6 Synchronedit.

Synchronedit [22] is synchronous system, developed on hybrid architecture. Each collaborator and his/her modifications are identified by a color. This feature helps collaborator

to inform about authorship of realized actions. Document Object Module (DOM) tree keeps track of each user modifications by means of an event handler.

Synchronedit provides awareness about presence (connected users), showing different color. All performed writing action is highlighted by the specified authorship color. Also, the user current position is marked with an author flag. Chat environment communication is provided by just clicking on the log in session, so users can start talk session with collaborators online. This is the way to coordinate their activities.

4.7 DocReview/Quick DocReview

[23][24] is Unix based asynchronous editors, implemented on centralized architecture. Users are allowed to make comments or to review a document published on Web. Firstly a document is uploaded and a form is filled then the document is converted into HTML format. Additional options can be added, for instance, assign titles, make a directory.

DocReview maintains event history (when element) by comments and last modified field (respectively Quick DocReview by viewing last modified and viewing comments). Presence history (who element) is provided by the last modified field (resp. by viewing comments text field, authorship name, date, and time).

Communication is achieved by posting comments or emails when a collaborator uploads a file, and sends emails invitation with the link of

uploaded document to others. This is the way to coordinate activities among collaborators.

Table 1: Awareness Elements in CWAs

Awareness Elements		Cooperative Writing Applications
Present Awareness Element	Presence	BSCW, Synchroedit, EtherPad, Gobby REDUCE, MoonEdit, AllianceWeb
	Identity	BSCW, Writely, Synchroedit, EtherPad, Gobby, REDUCE, MoonEdit, AllianceWeb
	Authorship	BSCW, Writely, Synchroedit, REDUCE,
	Action	BSCW, REDUCE, AllianceWeb
	Intention	BSCW, AllianceWeb
	Artifact	BSCW, Gobby, REDUCE, MoonEdit, AllianceWeb
	Location	REDUCE, AllianceWeb
	Gaze	
Past Awareness Element	View	BSCW, AllianceWeb
	Reach	BSCW, AllianceWeb
	Action History	BSCW, Equitext, Thinkfree, Writely, REDUCE, AllianceWeb
	Artifact History	BSCW, Equitext, Writely, Etherpad, REDUCE, AllianceWeb
	Event History	BSCW, Equitext, Thinkfree, Writely, Course & Project Forum, Doc Review, Quick Doc Review, Wiki wiki web, REDUCE, AllianceWeb
	Presence History	BSCW, Equitext, Thinkfree, Writely, Course & Project Forum, Doc Review, Quick Doc Review, REDUCE, AllianceWeb
Location History	BSCW, REDUCE, Alliance Web	
Action History	BSCW, Equitext, Writely, REDUCE	

4.8 Etherpad

Etherpad [25] is a real time synchronous collaborative writing editor, built on centralized architecture. Each author has colored identification along with his/her name, without any sign in procedure to enter into the collaborative writing environment. Authors invite others by sending invitation and information about who are joined (identity) and who is present (presence). By saved revision function, coauthors acknowledge the artifact history (how).

Communication chat is provided. There is a separate chatting box present on the Etherpad workspace. No mechanism has been provided explicitly for coordination.

4.9 Wiki Wiki Web

[26] is a web based asynchronous editor having centralized architecture. Users can edit a topic without permission from other author and hence the document consistency cannot be guaranteed. Event history (when) is possible by viewing “last modified field” at the end of every page. This field contains comments, name of user who makes comments, date,

and time on which comments are written. Name of user reflects in the last modified field if collaborator set user name in wiki editor before starting work, otherwise IP address is shown instead of user name. Mechanisms do not exist for coordination neither for communication.

4.9 Gobby

[27] implemented on hybrid architecture, is a synchronous cross-platform that enables developers to import source code or a document to edit at the same time. Gobby application fixes bugs and can be used by more than one user. Each user is identified by a color code that enables to see changes made by others. Presence awareness (who), identity, and authorship (who) are the information about who is present on workspace along with file name on which users are working on, as well as artifact information (what)(see Figure 2). Users are able to chat with others and also work on more than one document from any location.

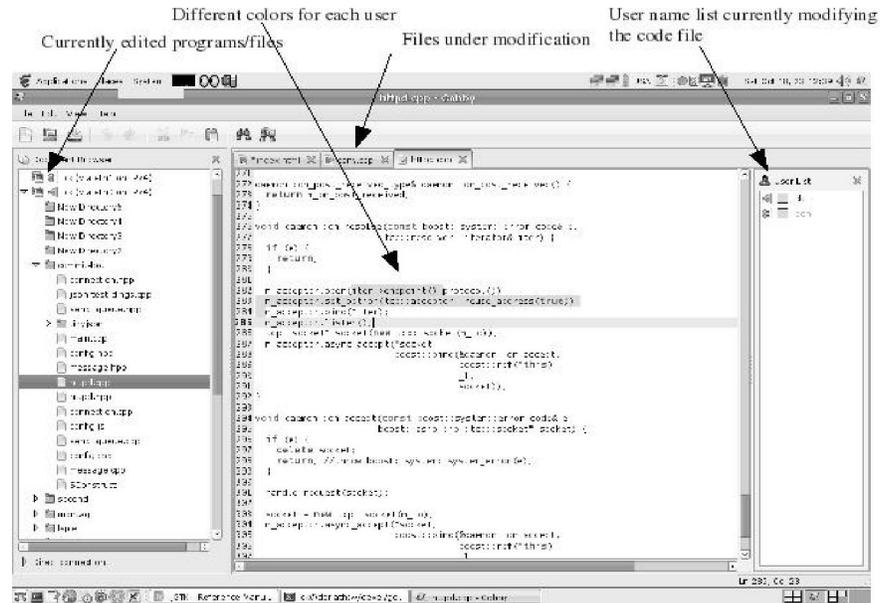


Figure 2: Awareness elements in Gobby

4.10 REDUCE

[16] is a synchronous editing application, developed on distributed architecture. Collaborators are notified with coloring scheme about different writing activities. For instance, red color is used to show active tasks, and green color indicates the idle tasks. REDUCE is not a free software. We evaluate awareness, communication service, and coordination functions by analyzing its published work.

Presence awareness is provided by showing who has authority to modify or view a particular document. Present users highlighted by their identity through user name list. REDUCE provides awareness location and authorship by toggle multi-user scroll bar. The user position is displayed within the document, indicating who is producing the document. REDUCE also provides knowledge about action and artifact by splitting window view showing users view and their working sections.

Action, event, presence, and action history (past element) are provided through modification director which notifies by flashing icons when user's contribution is update.

Collaborators coordinate their activities through set lock and freeze option. Communication service is done through email and by its own chat environment.

4.11 Moon Edit

[28] is a synchronous editing system, works on hybrid architecture. Awareness about presence and identity through user name list is provided.

Information about artifact is provided through menu bar. A user can modify a document locally by using "host" and remotely by "join" functionality. Users can exit from the shared space whenever they desire. Communication is done through own chatting environment. However, coordination mechanisms do not exist.

4.12 Alliance Web

[4] is developed with hybrid architecture, running on offline mode in case of network failure. User manager role assigns on each partition document, the role of each user (manager, writer, reader or null). This assignment is dynamic, so the manager has right to change the user role at any time. Writing action information is presented through event notification on the basis of nature of the cooperative production. External Call Facility (ECF) of Alliance Web helps in tracking authoring action such creation, open, saving a document, selection, copy, and paste writing operation, annotation, etc. Writing actions are represented by events and handled through a Distributed Event Management Service (DEMS)[5].

Presence awareness is achieved through user name list and session starting and termination alert message, when user signs in or/off, this action is notified to all members in session. Identity awareness is obtained by the help of user id, user name, working site or storage site id. Authorship knowledge is achieved by user role assignment manager. Intention comes to know through request of change role from co-worker to the manager.

Table 2: Communication and Coordination in CWAs

		Cooperative Writing Application
Communication	Email	BSCW
	Chatting	BSCW
	Computer Conferencing	BSCW
	Message Posting	BSCW, Equitext, Thinkfree, Writely, Course & Project Forum, Doc Review, Quick Doc Review, REDUCE
Coordination	Set Lock	BSCW, REDUCE
	Freeze	BSCW, REDUCE
	Exclusive Writing	Alliance Web

Artifact information arrives by viewing chronological event history. Location awareness is achieved through working site id. Information about view and reach also come through role assignment manager. Action/event awareness, artifact history knowledge, presence history, and location information is achieved through event notification alert message

Communication service is provided through email and chatting. The context-based/work-focus synchronous communication allows users to communicate with each other when their focus of discussion is simultaneously present on their displays[4]. The awareness system takes advantage of unique identifier associated to each object that is present in the shared document.

Coordination mechanism is maintained through exclusive writing and work proximity. Exclusive writing refers to production of document part when it cannot be accessed by any other coauthor. Work proximity concerns with changes in objects like figures, tables which are referred or produced by more than two authors. Concerned users are notified each time an actualization is made on these objects.

5. Discussion on Survey

A synchronous CWA lies in the same time-place region, while asynchronous one is placed in different time-place region (see Table 3). A real-time synchronous CWA implies maximum number of awareness functions as it creates illusion of face to face meeting that is why present awareness is more focused rather than past awareness elements. Whereas, asynchronous groupware application emphasizes those awareness elements which concern with shared production. In asynchronous nature of production more emphasize should be given to production evolution i.e. past awareness elements.

The classification helps a group to select a CWA according to its nature of production and mobility/availability of users. In case, users want to see their own modification or that of their colleagues,

synchronous CWA should be chosen. Otherwise, asynchronous type application be a good choice[29].

From the studied CWAs, BSCW and Alliance Web have maximum number of awareness elements: 14 out of 16, implying more effective performance. Whereas, Equitext has five awareness elements and Wiki Wiki Web presents least awareness function (only one). BSCW contains all type of communication means whereas Wiki Wiki Web does not offer any one. Coordination facilities are present in BSCW (set lock), REDUCE (freeze), and Alliance Web (exclusive writing and proximity).

6. Conclusion and Future Work

The purpose of this study is to assist people in selecting a Web based cooperative writing application (CWA). In addition to user friendly interface, convenient shared object management and efficient mechanism for processing, other essential features like awareness, good communication service, and efficient coordination mechanism should also be considered for evaluation of cooperative applications. CWA operating in real-time mode must have awareness information, and synchronous communication service i.e. instant messaging, video conferencing. In contrast, a non-real time CWA should have asynchronous communication service, e.g. email, message posting, etc. Efficient coordination mechanism is also necessary to maintain consistency in shared production. For this, we argue that "set lock" feature is more suitable as a user independently locks a document fragment and releases it when updated. In exclusive writing, a member asks the manager to get right of changing the document.

We plan to define an evaluation criterion for graphical and mathematical groupware. Such works need to include multiple objects like line, poly lines, ellipses, texts, formulae. The criterion will help to decide the expertise level of coworkers.

Table 3: Time and Space based classification of CWA

	Same/Different places
Same time	REDUCE, Syncroedit, Gobby, Etherpad, Writely, Moon Edit
Different time	Wiki Wiki Web, Course/Project Forum, Doc Review, Quick Doc Review, ThinkFree, EquiText, AllianceWeb, BSCW

References:

1. Applet, W., "WWW Based Collaboration with the BSCW System", Proc. of the 24th Seminar on Current Trends in Theory and Practice of Informatics, UK, 1999, 66-78.
2. Claudia B. R., Cleuza M. M. C. A., Louise M. J. de Seixas, Janete S. C., Fabricio R. T., Ademir da R.M., "Collaborative Writing via Web-Equitext", 7th Int. Conf. on Informatic Education, 2000, 411-415.
3. David P., Gutwin C., A Review of Groupware Evaluation, Proc. of the 9th IEEE Int. W. on Enabling Technologies: Infrastructure for Collaborative Enterprises, USA, 2000, 86-91.
4. Decouchant D., Gonzalo E. I., Martinez Enriquez A.M., Sonia M, Aslam M., "Contextual Awareness based Communication and Co-authoring Proximity in the Internet", Expert Systems with Applications: An International Journal, 36(4),2009, 8391-8406.
5. Decouchant D., Martinez A. M., Favela J., Moran A. L., Mendoza S., and Jafar, S. "A Distributed Event Service for Adaptive Group Awareness", MICAI-2000, LNAI 2313, pp. 506-515, Springer Verlag, Yucatan, Mexico, Apr. 2000.
6. Ellis C.A., S.J. Gibbs and G.L. Rein, "Groupware Some Issues and Experiences", Comm. of the ACM, 34(1), 1991, 39-58.
7. Gutwin G., Saul G., "A Descriptive Framework of Workspace Awareness for Real-Time Groupware", CSCW, 11(3), 2002, 411-446.
8. Henrique J. L. D., Nuno M. P., Legatheaux, J.M., Coordination and Awareness Support for Adaptive CSCW Sessions Proc. Of the 4th CYTED RITOS Int. Workshop in Groupware Systems, Brazil 1998, 241-244.
9. Hiltz, S.R, Turoff, M., The Network Nation, Revised Edition, Cambridge, MA; MIT Press 1993, Original Edition 1978.
10. Jonathan G. "Eight Challenges for Developers", Comm. of the ACM, 1994, (1), 93-105.
11. Marcelo C., Patrick A. W., James D. Carley K. M. "Identification of Coordination Requirements: Implications for the Design of Collaboration and Awareness Tools", Proc. of the 2006 20th Anniv. Conf. on CSCW, Banff, Alberta, Canada, 2006, 353-362.
12. Paul D., Victoria B., "Awareness and Coordination in Shared Workspace", Proc. of the 1992 ACM Conf. on CSCW, Ontario, Canada, 1992, 107 - 114.
13. Saul G. Roseman, M, "Support for Group Work", J. of Management Information Systems, 11(4), 1995,115-148.
14. Sylvie N., Robert, J.M., Empirical study on Collaborative Writing: What Do Co-authors do, Use and Like? CSCW, 13(1), 2004, 63-89.
15. Tom R., A Survey of CSCW Systems, Interacting with Computers, 3(3), 1991, 319-353.
16. Yang Y.,Sun, c., Zhang, Y., Real-time Cooperative Editing on the Internet, IEEE Internet Computing, 4(3), 2000, 18-25.
17. <http://www.w3.org>
18. www.thinkfree.com
19. www.writely.com
20. www.courseforum.com
21. www.projectforum.com
22. www.synchroedit.com
23. <http://www.depts.washington.edu/bkn/public/PURL/info.html>
24. <http://www.quicktopic.com/cgi-bin/docreviewintro.cgi>
25. www.etherpad.com
26. <http://www.c2.com/cgi/wiki?WikiWikiWeb>
27. <http://www.gobby.0x539.de/trac/>
28. www.moonedit.com.
29. Yasir Muhammad, Jabeen Shahida, Aslam Muhammad, Martinez Enriquez A.M., Awareness Elements in Web Based Cooperative Writing Application, 2nd Asia-Pacific Conference on Computational Intelligence and Industrial Application, 2009.

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