CAWS: Visualizing awareness to improve the effectiveness of co-authoring activities

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ABSTRACT
Knowledge of the actions of other users is essential to the design of an effective collaborative authoring system. The reasons for this are rooted in the concept of awareness of individual and group activities. This research presents CAWS, a collaborative authoring system that builds upon several areas of research including studies of co-authoring practices, studies supporting awareness in collaborative environment, systems supporting collaborative authoring activities and wikis. An example usage scenario is described, highlighting the way that CAWS can facilitate collaboration by supporting users' editing awareness, users' status awareness, users' actions awareness, users' roles and responsibilities awareness, users' annotation awareness and awareness of document deadlines. The features of the tool are described, specifically how they relate to the theoretical principles of awareness on which it is based.

ACM Classification: H.5.3 [Group and Organization Interfaces]: *Asynchronous interaction*, *Collaborative computing Computer Supported Cooperative Work, Web-based interaction*. H.5.2 [Participant Interfaces]: *Participant-centered design*. H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

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INTRODUCTION
Developers of collaborative authoring tools design their systems in different ways, as different systems are tailored to different problems. However, when designing a collaborative system, there are several aspects of collaboration that must be taken into account. Users collaborate on numerous tasks, which require different levels of information. When collaborating in collocated environments, users are implicitly aware of the events that are taking place in the world around them. However, when collaboration takes place either partly or completely in an online environment, this information can be lost if the environment does not attempt to reproduce it.

This article describes a new co-authoring tool called CAWS[1] (Co-Authoring wiki based system) which differs from previous work on co-authoring tool in three ways:

1. It integrates and expands upon a variety of observations and previous models of co-authoring practices, awareness, collaborative authoring systems and wikis.
2. It is intended to assist the document development process for real-time collocated and distributed groups at all stages from planning to writing and styling the document.
3. It attempts to support the personal, informal, group and workspace awareness of its users.

RELATED WORK
CAWS builds upon several areas of research including studies of co-authoring practices, studies supporting awareness in collaborative environment, systems supporting collaborative authoring activities and wikis.

Co-authoring practices
There have been numerous studies of collaborative authoring practices, which have outlined problems as well as possible writing strategies and group dynamics. The outcome of field studies previously undertaken as part of this research [17] backed previous research studies in collaborative authoring practices [21, 24, 27, 26] as well as identifying co-authoring practices when writing on the web. These studies provided background knowledge of how users approach a collaborative authoring activity and their positive and negative reactions when collaboratively authoring a document. Most importantly, the research highlighted the key problems encountered with available technologies. The field studies also highlighted users' concerns when writing in a web-based system [17].

Collaborative authoring practices vary from group to group as different people approach the problem differently. Interviews with successful collaborative writers indicate [13] that both asynchronous (working on different document sections or working on the same document at different times) and synchronous (meetings, or joint editing ses-

[1] http://caws.ecs.soton.ac.uk

sions) collaboration are used. Coordination (eg. partitioning tasks into subtasks, assigning people to tasks, dependencies between tasks) is crucial to the group activity [13]. Coordination needs to be dynamic as the changes that an author makes on a section might have repercussions in another section, changing the initial plan.

Noël and Robert [21] categorize the positive and negative aspects of collaborative authoring from 41 respondents to their studies. They identify the positive outcomes to collaborative writing as "*obtaining a better product*" and the negative outcomes as "*making the task more difficult*". It was found that co-authors encounter problems stemming from: reconciliation of different writing styles, delays in producing the document, difficulties in following schedules, unequal division of work, difficulties in coordination, and management of authors' emotions. Group or social issues can also cause problems, including difficulties in communication, conflicts between members, and problems in conciliating members' abilities.

These problems have been outlined by Weng and Gennari [27] as well as the survey previously undertaken for the purpose of this research [17]. The field study also highlighted that problems arise when co-authors are not aware of other users' actions, movements, status and points of view on contentious issues. These are the kinds of awareness present when co-authors work on a project in the same location.

Awareness in groupware

Within a collaborative process, awareness of individual and group activities is always required to coordinate those activities [8]. There has been significant research in the CSCW field into the role of awareness in groupware systems. Dourish and Bellotti [8] define awareness as "*understanding of the activities of others, which provides a context for your own activity*". Gutwin and Greenberg [11] examine workspace awareness as a combination of the types of awareness that are present in daily life [10], but within an online system as "*the up-to-the-moment understanding of another person's interaction with a shared workspace*". This includes knowledge about what others are working on, what they are doing and their future plans (personal, social, group and informal awareness).

Awareness of participants' activities with respect to a collaborative context is therefore a critical issue for collaborative authoring systems [8]. Awareness can take several forms and can affect the group members as individuals or as a group. Figure 1 represents a summary of the types of awareness that have been categorized by different researchers in the HCI and CSCW fields [5, 8, 10, 11, 19].

Existing CSCW systems vary in the methods they use to support awareness: *informational* [2] and *role restrictive* [8]. In the informational method, explicit facilities are provided through which collaborators inform each other of their activities [8]. Informational methods update users on what has happened since their last visit, but rely on use of the system to discover changes [2]. Role restrictive methods arise from explicit support for roles in collaborative

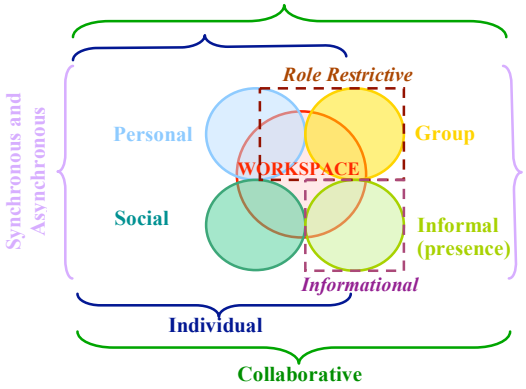

Figure 1 - Type of Awareness: Figure showing different types of awareness identified in research.

systems; a role describes an individual's relationship to the shared work objects and to other participants [8]. Types of awareness can be synchronous and asynchronous; synchronous when authors are working together in real time, asynchronous when not working together in real time.

Personal Awareness refers to information that users maintain about themselves and their roles in the group. It can be synchronous (eg. current whereabouts within the system) or asynchronous (eg. where the user has been within the system) [10, 19]. **Social awareness** refers to information that users maintain about others in social or conversational contexts: for example, whether a person is paying attention, their emotional state or level of interest. This kind of awareness can be asynchronous (eg. knowledge that a partner has replied to a comment), or synchronous (eg. actively paying attention to or replying to the queries of other users) [10]. **Informal awareness** involves knowledge of who is present and what they doing: the kind of awareness implicitly present in an office context [10]. Morán et al [20] refer to it as *informational awareness*. **Group awareness** gives an overview of other users' roles, activities, movements and status in the process. It includes people's roles and responsibilities, their positions on issues, current status, and group processes [5, 8, 10]. **Workspace awareness** concerns user presence in the workspace and what users are currently doing: up-to-the-minute knowledge about other people's interactions with the shared workspace. In face-to-face activities, workspace awareness is naturally present. Workspace awareness combines the types of awareness that people maintain when working in a group [10] [11].

Collaborative authoring systems

Several systems have explored collaborative interfaces that allow multiple users to write collaboratively in a group. For example, tools which replicate the appearance of and/or use Microsoft Word such as **CoWord** [25] and **TellTable** [1] present enhanced features over the traditional word processor. CoWord, for example, provides version control, unconstrained collaborative editing and concurrent editing and commenting in the same document. Similarly, Telltable tracks participants' current and past activity (through the OpenOffice.org "track changes" feature), and allows participants can track who is editing the document at any time.

Collaborative web-based editors which support synchronous writing exist, such as **Gobby** [6], **MoonEdit** [7] and **SubEthaEdit** [23] which use a synchronous shared editor in which users are assigned colors once they log in. The **Bloki**[28] and **ProjectForum** [4] systems are designed around the wiki concept [16] and present enhancements upon previous wiki implementations by incorporating a blog and a locking system to the document while editing (allowing each user to know who is editing the document). In the case of Bloki, the ability to see participants' whereabouts in the system are shown, with a 'recent changes' feature that allows the last changes to be seen at a glance.

BSCW [22] (Basic Support for Cooperative Work), **Google Docs & Spreadsheets** [9] and **Workshare Professional** [3] take a different approach to collaborative authoring by creating new systems. BSCW enables collaboration through shared objects such as document URLs, notes and calendars. Google Docs & Spreadsheets is semi-synchronous (as it refreshes the screen every two minutes). Workshare Professional is a commercial tool used to share documents and to verify, secure and audit changes. It can compare two documents and identify changes.

Many collaborative authoring systems have been implemented since the 90s. However, none are in widespread use [14]. In order to develop a tool, which addresses common co-authoring problems, a deeper understanding of why available tools are not used is necessary, with particular reference to why users might not want to use them. Research has outlined [14] that a major reason for this phenomenon is a gap between theoretical assumptions and reality that is larger than researchers thought. It has also been noted [25] that users tend to choose tools that appear familiar to them. These tools were chosen for comparison to CAWS as they represent a set of tools, which improve upon previous implementations and present different innovative designs, either in the form of technological advances or findings from user studies.

Unlike these systems for collaborative authoring activities, CAWS focuses on supporting collaboration during the entire process synchronously and asynchronously, providing users with information about other users' whereabouts while logged in, users' actions taken in the workspace and users' roles and responsibilities, in addition to a centralized system for formatting the document and a bibliography system. These features are implemented in a way based on the wiki concept, which gives an established way of writing on the Web.

Wikis

Wikis have achieved widespread success since the concept was created in 1995 by Ward Cunningham [16]. Applied in multiple application domains, a variety of wiki engines have been developed [21]. Much research has been conducted into the use of wikis for collaborative writing. Wikipedia [22] is the most prominent example of the use of wikis for collaborative writing, consisting of a web-based encyclopaedia that anyone can edit. However, the MediaWiki software used for Wikipedia presents numerous limitations when awareness in collaboration is considered [15]. This arises from the fact that its design goals differ from traditional collaborative authoring tasks; it is not seeking to produce professionally structured papers. Research has investigated providing users with the ability to determine the structure and appearance of wiki pages, as well as supporting editing of structured wiki pages to improve effective collaboration [12].

CAWS: CO-AUTHORING WIKI BASED SYSTEM

Example scenario

A group of people residing in different parts of the world wish to work together to write a journal article on a common topic. Part of the group resides in Europe, while the other in the USA. Of the members, John and Mary reside in England, Sally and Chris in Scotland, Zoe in Belgium, George in California, and Stuart in Florida. They face not only dislocation in their geographical location but also in time zones. As a result, there are only few hours a day in which they all be awake. They decide to use CAWS as a shared environment in which they can collaborate on the document.

John logs into CAWS and selects "create new document" which he calls "journal article". Next he invites the other users by entering their email addresses. The other users join the document after receiving the emails.

John logs in to CAWS and selects the document "journal article", which shows the 'front page' of this document. As the creator of the document, he has control over the rights granted to other group members. The 'front page' displays the *user status* and the *activity log*. From the *user status* box he realizes that he is not the only group member currently online. Mary, Sally, Zoe and George are also online. Zoe and Sally are using the 'Editor' section of the system. Zoe is restructuring the document while Sally is editing the Introduction to the document. Mary is in the 'Blog' part of the system and is replying to a blog post called "part 1" previously created. George is in the 'style' part of the system and is customizing the style of the document. The user status box also shows that Chris and Stuart were online three and six hours before John logged in. From the *activity log*, John sees that Chris wrote a blog post called "part 1" and that Stuart replied to it and wrote an initial introduction to the document.

John starts to plan the activity by using the "planner" feature to assign roles and responsibilities. Zoe realizes that John is using the planner from the user status box shown in the editor. John assigns group members to sections. The other group members can insert their estimates for the time that it will take to finish their sections. Estimates can only be set by the user assigned the task. Development of the document can now begin.

Sally logs into CAWS to start working on the section assigned to her. She realizes that Zoe and John are also online and working on their individual sections. Sally's section is closely related to what John is writing so before she continues, she examines John's section to see what he is writing (she can view his changes in real time). Sally then goes

Figure 2 - CAWS Document front page: a) Indicator showing who is online and what are they doing within CAWS; b) Indicator showing recent activities within CAWS.

to work on her own. While writing, she notices the other users finish and log out. After finishing her own work, she saves her changes and updates her remaining hours in the planner, before logging out.

Several hours later, George logs in. It is immediately apparent that nobody else is online from looking at the *user status* box. The *activity log* highlights the changes made to the document by the other users. He goes to the editor to continue to working on his section of the document. George takes a one hour lunch break, and after returning, realizes that Stuart has logged in. He finishes his changes and saves them. Before logging out, he returns to the document 'front page' and the *activity log* highlights that Stuart has replied to a comment that he previously added to Sally's section. After reading the comment, he updates his hours remaining and logs out.

CAWS' awareness mechanisms inform the group members of what happening in the document, both while they are logged in, and also what has happened while they were logged out. The planning system allows progress within

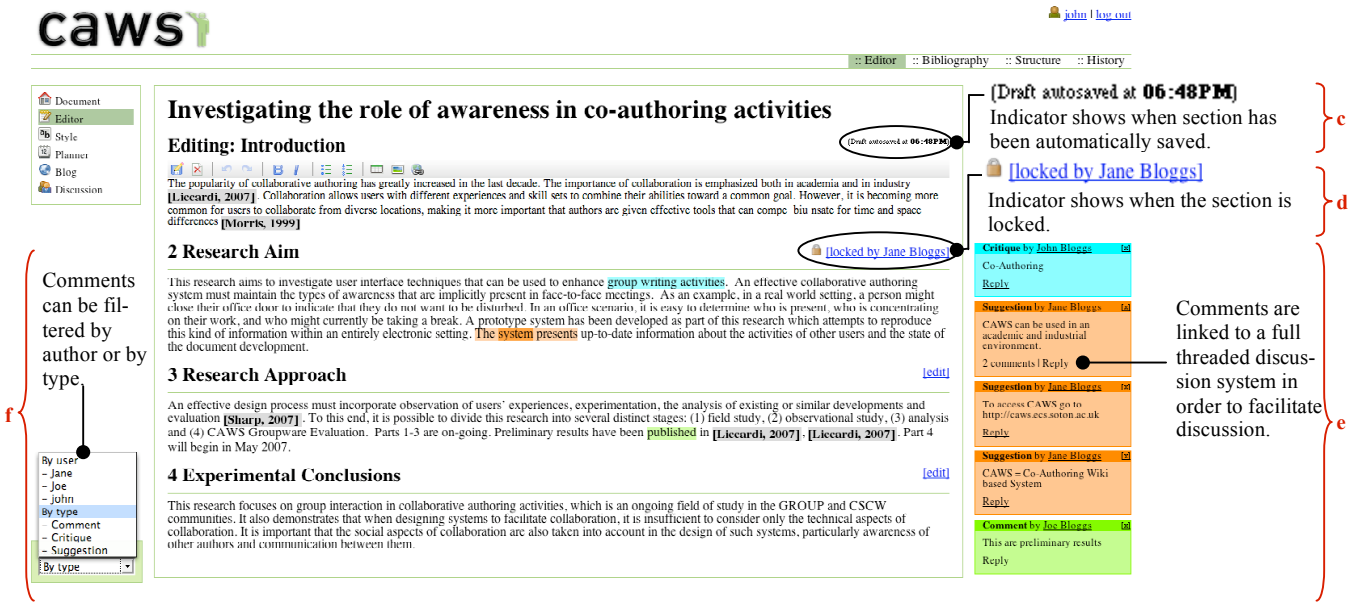

Figure 3 - CAWS Editor Page: c) Indicator showing when the section is automatically saved, ensuring that the section text will not be lost if the page is closed; d) Indicator showing who is editing the section; e) Users can reply to comments, which are linked to a threaded discussion system. The number of replies is show beneath the comment; f) Comment filtering system - users can filter by type or by author.

the document to be tracked and warning of upcoming deadlines.

After several weeks, John examines the *document summary* and realizes that there is a section of the document in which users have conflicting views. He also realizes that one section is behind schedule as the planner highlights the section in red. John creates a discussion in order to understand the different group members' viewpoints on the controversy. John then asks the group members responsible for the delayed section the reason for the delay. Sally, the editor and second author, answers that she has encountered a problem and asks to extend the deadline. As the administrator, John changes the schedules. The document is finished in time for the deadline.

Design Goals: Visualizing Awareness

The aims behind CAWS were guided by the findings of past research in collaborative authoring practices and current collaborative authoring systems, in addition to a survey on collaborative authoring practices study [17]. Based on this, this research hypothesized that an effective interface for collaborative authoring should support awareness of participants and group activities.

Facilitating users' awareness is crucial to effective collaborative activities. Awareness of users' activities, whereabouts, roles and the motivations behinds their actions is supported in different ways in order to provide an overall view of the collaborative activity.

History of users' actions

One of the awareness mechanisms in CAWS is to maintain a history of users' actions. Each time a user performs an action within the system, the event is added to an "activity log", which is displayed on the 'front page' of the document (Figure 2). The group member's screen name is displayed along with the event. The events shown in the activity log include notifications of changes to the document itself, replies to comments, and changes to the document style. Events are displayed in chronological order, but related events are grouped together - for example, if two users both make changes to the same section, the activity log might display "George and John edited *Introduction*".

The purpose of this is to provide information on the order in which events occurred, interactions between users, and also the interactions between the users and the system.

Events are highlighted if they occurred since the last time the user viewed the activity log. This provides the user with an effective means of identifying recent changes to the document, minimizing duplication of effort. Users joining the collaborative activity while it is in progress can view previous interactions between and the actions taken by other group members and gain a better understanding of the history of the document.

A history of users' actions is provided for several reasons. Firstly, it provides notification of activity during the development of the document. It provides an effective means of monitoring all users' actions since the start of the collaborative activity, which is a concern when operating in an academic environment [18].

Users' Whereabouts

Another awareness mechanism tracks users' whereabouts in the tool. As a user navigates through the system, their movements and actions are logged. This is used on the 'front page' of the document (Figure 2), to show the current status of all users. Each group member's screen name is shown, along with their time of log in, status (set either manually by the user or automatically by the system) and up-to-date information about their location within the system. This information has the potential to provide clear and up-to-date information about other users' movements and the activities they are currently engaged in.

A smaller status box continues to show the information in a reduced form as the user navigates the various pages related to the document. This cut-down version only shows information about users who are online (Figure 2 and 3).

Division of Activities

Many users that responded to the survey described the *"planning"* part of the document development process as being crucial to its success. This includes explicitly dividing up the document into sections, assigning roles to users and assigning users to write specific sections of the document, and estimating time of completion. To address these issues, CAWS includes several mechanisms for managing roles and responsibilities within the tool.

A *"structure"* mechanism allows the group members to create a structure for the document, defining the sections which the document is to be divided into. Planning document activities is integrated into CAWS. Users can be assigned roles in relation to sections (for example, "author" or "editor"). Once assigned a role, users can estimate the time needed for the completion of the section, and set a deadline and target word count.

The planning part of CAWS captures this information in a graphical way. This is used to summarize information about the document status. A section that has a deadline with a week is displayed in red, while a section with a deadline within two weeks is displayed in yellow. A bar chart shows the percentage of work done with respect to the number of hours remaining, as well as information about deadlines and word count. This provides an overview of the document status.

Comment visualization

To be able to understand users' points of view, it is important to facilitate commenting as well as providing the ability to discuss the comments in depth. Comments can be filtered by type and author. A section of text with comments attached is highlighted, with an increase in intensity when comments overlap (Figure 3). This presents the ability to identify sections of the document with the most comments. The comments are linked to a full threaded discussion system in order to facilitate discussion. Finally, an agree/disagree system allows users to express their support or opposition for the views expressed in comments.

CONCLUSION AND FUTURE WORK

This paper presented CAWS, a co-authoring wiki based system that enables users to collaborate synchronously and asynchronously on a common document. The design of the features it incorporates was guided by prior research studies on co-authoring practices, studies supporting awareness in collaborative environment, systems supporting collaborative authoring activities and wikis, The system aims to support collaborative writing with several awareness mechanisms.

Awareness is the most valuable aspect of the design of CAWS. It has been explained how CAWS can facilitate collaboration by supporting users' editing awareness, users' status awareness, users' actions awareness, awareness of users' roles and responsibilities users' annotation awareness and awareness of document deadlines.

Although the system as it currently stands is stable, it still has a need for an instant messaging capability that has yet to be incorporated. Furthermore, the system of roles and responsibilities in the planning system need to be linked with the editor in order to provide further editing awareness.

The annotation system was described as a useful mechanism for gaining insight into other users' points of view. To support this usage, a polling system will be added to CAWS to provide users with the ability to express their points of view. In addition to the technical implementation, a longitudinal study will be run over several months with users using CAWS to undertake collaborative authoring activities for an academic publication and student group project.

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