# E-Collaboration Systems: How Collaborative They Really Are

## Analysis of Collaboration Features of Electronic Collaboration Systems

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*Abstract*—**Electronic Collaboration Systems support employees in communication, coordination and collaboration tasks to work together to a common purpose to achieve business benefit. However, the marketplace of E-Collaboration systems is multifaceted and is made up of various types of systems with differing emphasis. E-Collaboration systems may be well suited for communication tasks or coordination tasks (e.g., collaboration systems with focus on project management), but lack support of collaborative tasks – and vice versa. To identify the extent of the support of "real" collaboration of E-Collaboration systems, an analysis of collaboration features is applied to a number of E-Collaboration systems. Although we focus entirely on collaboration features and present results on a number of E-Collaboration systems with above-average collaboration emphasis, significant differences in extent and quality of collaboration support can be detected.**

*Keywords-electronic collaboration; electronic collaboration systems; Enterprise 2.0; social software; social interaction*

## I. INTRODUCTION

Social software and social media, like Facebook, Xing, LinkedIn, Twitter, Flickr, Wikipedia and many more, are highly accepted in private use, and modern life became almost unthinkable without these tools – at least for the increasing communities of digital natives. The transfer of the highly accepted utilization of social software and social media from private use into companies is called *Enterprise 2.0*. Besides using weblogs, wikis and social networks to communicate with customers, these emergent social software platforms are used within enterprises, or between enterprises and their partners or customers [1]. Software solutions we used to call groupware and Computer Supported Cooperative Work (CSCW) software for decades incorporated these tools and got a significant development stimulus.

Team collaboration and willingness to share knowledge are increasingly claimed by companies as central requirements for their employees. Working in teams requires the ability to communicate, coordinate and cooperate. Employees have to share their individual knowledge and collectively manage the corporate knowledge. Team and community building activities and organizational measures affecting the social environment of the collaborating individuals can be supported by information systems supporting these collaborative tasks. Electronic collaboration systems (E-Collaboration systems) assist and support employees in different phases of social interaction within teams: communication, coordination, cooperation/ collaboration and networking.

Complete E-Collaboration systems have to provide high-quality support in all four phases of social interaction. The marketplace of E-Collaboration systems is multifaceted and is made up of various kinds of systems and tools with varying complexity. But do they really support all types of social interaction sufficiently? To be able to collaborate we have to be able to communicate and coordinate. Thus, communication and coordination features are actually preconditions of "real" collaboration.

In this paper we want to figure out whether and how well E-Collaboration systems really support core collaboration features. We will examine typical E-Collaboration systems for their ability to support collaborative activities among users. A feature-based evaluation approach is presented that identifies the degree of coverage of typical collaboration requirements. Therefore we will focus only on features that support the phase *collaboration* of social interaction. Features enabling communication, coordination and connection/networking will not be covered in this paper and are taken for granted.

In Section II we discuss the four types of social interaction and narrow down the term collaboration as the interaction type in focus. Section III briefly describes the marketplace of E-Collaboration systems we will analyze. The features of collaboration that are supported by E-Collaboration systems are introduced in Section IV. In Section V we present the results of evaluating a number of E-Collaboration systems whether they effectively support these features and discuss findings in Section VI. Section VII concludes this paper.

## II. TYPES OF SOCIAL INTERACTION IN ELECTRONIC COLLABORATION

Riemer [2] describes E-Collaboration systems as "software for supporting communication, coordination and cooperation between people processes in groups". Riemer's definition is based on the basic types of social interaction that can be found in Computer Supported Cooperative Work (CSCW) systems and groupware: communication – coordination – cooperation [3]. In a similar way Cook [4]

uses four primary functions to classify social software: communication – cooperation – collaboration – connection.

Communication allows people to converse with others and exchange information with the help of synchronous (e.g., chat, conferencing tools) and asynchronous (email, weblog, microblogging) communication tools [2][4].

Coordination allows a temporal or issue-related matching and agreement on tasks and resources. Typical operations of coordination support team members in coordinating appointments, processes and tasks in projects, plus surveys and workflow management.

Collaboration encourages people to work with each other on particular problems, with shared commitment and goals [4]. Collaborative activities involve working on some kind of content in a team. Creating and editing of the content can occur in an asynchronous or synchronous way. The content could, for example, comprise some kind of document or graphics, or collecting or creating information and ideas on a topic with the help of a wiki or a virtual whiteboard. Another kind of support for collaborative activities is provided by shared applications or shared desktops that offer synchronous working using the same applications simultaneously. Collaboration and cooperation use the services of communication and coordination.

Connection refers to networking technologies that enable people to make connections with and between both content and other people [4]. Social networking is the most prevailing technology for connection, but there are also a number of enabling technologies like people profiling and people search.

In terms of this work E-Collaboration systems are defined as *software for supporting and enabling communication, coordination and collaboration between people in shared projects, processes and teams within organizations and for cross-organizational use* (following Riemer [2]). Thus complete E-Collaboration systems have to support all four types of social interaction – the 4Cs:

- Communication
- Coordination
- Collaboration
- Connection

Even though complete E-Collaboration systems have to support all of these types of social interaction, the focus of this paper is on the provision of features for the core collaboration activities. The reason for this emphasis on collaboration is that the evaluation of a number of E-Collaboration systems according to these 4C categories showed, that some systems provide a variety of coordination or communication features, but fall short when it comes to supporting real collaboration [5].

In a narrow definition *to collaborate* means to work with others on a non-routine cognitive task – that is, working together [6]. Enterprise collaboration is a working practice whereby individuals work together to a common purpose to achieve business benefit [7]. Electronic collaboration (e-collaboration) is operationally defined in [8] as collaboration using electronic technologies among different individuals to accomplish a common task. Working together

in a collaborative way is identified by cooperation, shared commitment and common goals. Examples of collaboration are working together on shared objects, or conjointly creating and modifying electronic documents (synchronous or asynchronous) [2]. Therefore we perceive collaboration as a special case of ICT-based cooperation where the main criteria are a collective goal-oriented behavior and collective responsibility for the result that are subjectively experienced by the participants. This definition presupposes types of personal work organization that assume high autonomy and intrinsic motivation of the participants (i.e., team members).

### III. E-COLLABORATION MARKETPLACE

The marketplace of E-Collaboration systems consists of various heterogeneous system classes. There exists a large variety of open source and commercially available tools for team cooperation and collaboration. Some tools were developed out of former project management or content management systems, others put an emphasis on supporting communication with conferencing tools or originate from groupware solutions.

Several scientific and commercial market studies on E-Collaboration systems aim at structuring and organizing available software packages into system classes and categories and set up descriptive criteria, refer, e.g., to [2][9] [10][11][12].

According to our definition of E-Collaboration systems, only those systems will be part of a detailed analysis that support all four basic types of social interaction (full support or partial support per interaction process, but all types have to be supported). Applying this limitation means that the vast number of single function tools, e.g., all those wikis, weblogs, chats, video conferencing tools, project management tools, content management tools, tagging or bookmarking solutions, etc., that offer only a limited number of features according to their system class, but do not cover the entire spectrum of functions for team collaboration, are excluded from the evaluation.

Based on a detailed market analysis in which we analyzed the functional range of candidates, we set up a list of about 50 tools to be included in our study. The entire evaluation process is described in [5].

### IV. COLLABORATION FEATURES

Based on a literature study (e.g., [2][13]), an analysis of various studies and reports on the evaluation of E-Collaboration systems, CSCW software and groupware tools [9][12][14][15], as well as a number of interviews with experts in the field of CSCW and electronic collaboration, a set of typical functionalities of E-Collaboration systems that especially support collaborative activities was identified (Table I). These core functionalities or features of electronic collaboration are arranged in six subgroups. They provide the basis of a feature-based analysis of a representative number of E-Collaboration systems presented in the next section. They cover features regarding shared content and document creation (asynchronous and synchronous) as a core functionality including supportive content management features as well as social software and connection.

TABLE I.        FEATURES SUPPORTING COLLABORATION

| Feature / functionality | Weight |
|---|---|
| *Asynchronous content sharing* | *20,00%* |
| Documents | 9,00% |
| Multimedia content (audio, video, images) | 4,00% |
| Document libraries | 7,00% |
| *Synchronous real-time editing* | *11,00%* |
| Collaborative real-time editor | 8,00% |
| Whiteboard | 3,00% |
| *Content management* | *18,00%* |
| Versioning | 4,00% |
| Check in/check out | 4,00% |
| Access control | 6,00% |
| Up- & download | 4,00% |
| *Creating and editing documents out of the shared workspace* | *15,00%* |
| Text documents | 5,00% |
| Spreadsheets | 1,50% |
| Graphics and presentation | 2,50% |
| MS Office integration | 6,00% |
| *Social software* | *24,00%* |
| Wiki | 5,00% |
| Weblog | 5,00% |
| Social tagging | 4,00% |
| Social bookmarking | 3,00% |
| Social cataloguing | 1,00% |
| Social presence | 3,00% |
| Tracking | 1,50% |
| Rating | 1,50% |
| *Connection* | *12,00%* |
| People profiling | 3,75% |
| People search | 3,75% |
| People tagging | 1,50% |
| Networking services | 3,00% |

Most of the activities in electronic collaboration involve creating or editing some kind of document jointly by several persons. E-Collaboration systems should thus offer features for asynchronous and even synchronous editing of documents. Concerning the asynchronous way of sharing documents or other kinds of files like multimedia content, the systems provide various kinds of libraries that support the collaborative editing of content by functionalities like check in/check out. The synchronous editing of documents allows for several team members to work on the same document at the same time. Thus, for synchronous collaboration the systems have to support functionalities for displaying who is editing which part of the document, highlighting the changes and locking parts of the document.

Brainstorming and creating ideas together is supported by virtual whiteboards that can be edited simultaneously and often are complemented by some kind of chat or instant messaging system to communicate while collaborating.

Versioning and access control are crucial for synchronous as well as asynchronous collaboration on documents or content.

Another important aspect concerning the collaboration on documents is, whether files can only be up- and downloaded to the platform or whether it is possible to create various kinds of documents directly out of the shared workspace. Our evaluation distinguishes between text documents, spreadsheets as well as graphics and presentation. Creating and editing documents out of the shared workspace explicitly focuses on documents and goes beyond just creating a webpage with the help of an online editor.

The possibility to create and edit Microsoft® Office documents within the workspace qualifies E-Collaboration systems for collaboration of standard teams as these are the prevailing document formats. Creating and editing documents within the shared workspace without having to up- and download the files, showed to be a significant feature for E-Collaboration systems to be integrated into daily work routines. Workspaces supporting this functionality have got higher chances to replace the desktop and to be used as the standard workplace that supports all daily collaborative working routines. Whereas E-Collaboration systems, that provide only up- and download of documents, risk being used as a repository for documents instead of supporting active collaboration. Such systems are often not used like a standard workplace, but the users enter the E-Collaboration system in order to get documents to be edited locally and afterwards the documents are stored within the platform again.

Among the social software tools, wikis have turned out to be a very flexible and suitable tool for collecting and structuring ideas and information on a topic together in a team. With the help of weblogs, news can be published and commented or discussed by other users. Social tagging, social bookmarking and social cataloguing refer to organizing content conjointly and to provide information for the other team members in a structured way. Thus, team members should get easy access to the collected information on selected topics.

Social presence provides information of the team members´ state and can reveal where people are, whether they are available for communication or concurrent content editing, and which is the best way to contact them. Thus, social presence serves as a basis for synchronous collaboration. Tracking refers to following the activities or tasks of other team members or the status of a document and thus provides transparency. Rating content is a very common feature for blog posts, but systems also provide rating for other kinds of content. The team can evaluate content together and thus gain a common understanding of the state of the art concerning a certain topic.

Finally, a very important aspect of E-Collaboration is connection. Features for connecting people, but also for establishing a connection between content and the team members who create the content, are a distinguishing characteristic for systems that really support collaboration. These features comprise people profiling, people search, people tagging and the support of social networking. Profiles provide information about the team members, their expertise and contact details as well as their organizational integration. Profile sites, that also provide space for personal details,

support social networking activities. For example, the connection between content and the people creating the content is achieved by showing a picture of the author next to the documents, comments, blog posts etc. of this person. Clicking on or moving over this picture provides the basic profile information of the author and also the contact details. Some E-Collaboration systems combine the brief profile with instant messaging and presence information. These features support searching for experts and easy locating of the right contact person even if the users do not know each other in person.

In order to assess E-Collaboration products and to calculate an overall measurement of collaboration coverage we perform a value of benefit analysis. Each feature is assigned an individual weight (Table I) indicating dependencies and relevance in an overall weighted sum. Those weights refer to a standard scenario of team collaboration. In case of choosing an E-Collaboration system for a specific collaboration scenario these weights have to be adapted to the particular situation.

## V.    EVALUATION OF E-COLLABORATION SYSTEMS

The evaluation of E-Collaboration systems is based on the above described features (Table I) that were found to be relevant for providing an environment where electronic collaboration is supported at the best. Out of the list of 50 systems that support communication, coordination, collaboration and connection, 10 were chosen to be analyzed with a focus on how well they are suited for core collaboration activities:

- Alfresco Share, Community v3.4.0
- Collanos Workplace 1.4.0.2
- Jive SBS 4.5
- Microsoft® SharePoint Server 2010
- Socialtext 4.0
- Liferay Portal, Community Edition v6.0.5 CE
- PBWorks, Basic Edition
- Huddle
- EGroupware, v1.4
- Simple Groupware, v0.701

Table II presents the results of evaluating these E-Collaboration systems whether they implement the features introduced in Section IV. For the sake of simplicity each score in Table II is marked by ● if it is implemented and ○ if it is not available. Of course an assessment based on Boolean decisions is not sufficient for a detailed analysis and will be replaced by a graduation of the scale (e.g., on a scale from 0 to 4) for a more finely grained evaluation.

Alfresco provides very well supported and integrated document and content management features by offering all supporting functionalities that are needed in order to achieve efficient collaboration on documents in a team. With the help of activity feeds it is possible to track who added, edited or commented on which parts of the content. The social aspect is not the focus of Alfresco and thus there are no features for social networking activities.

TABLE II.    EVALUATION OF COLLABORATION FEATURES

| Collaboration feature | Alfresco Share | Collanos | Jive | MS SharePoint Server 2010 | Socialtext | Liferay | PBWorks | Huddle | EGroupware | Simple Groupware |
|---|---|---|---|---|---|---|---|---|---|---|
| **Asynchronous content sharing** | | | | | | | | | | |
| Documents | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Multimedia content (audio,video,images) | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Document libraries | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| **Synchronous real-time editing** | | | | | | | | | | |
| Collaborative real-time editor | ○ | ○ | ○ | ● | ○ | ○ | ○ | ○ | ○ | ○ |
| Whiteboard | ○ | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ |
| **Content management** | | | | | | | | | | |
| Versioning | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Check in/check out | ● | ○ | ○ | ● | ● | ● | ● | ● | ○ | ● |
| Access control | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● |
| Up- & download | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| **Creating and editing documents out of the shared workspace** | | | | | | | | | | |
| Text documents | ○ | ● | ● | ● | ○ | ● | ○ | ● | ● | ● |
| Spreadsheets | ○ | ○ | ○ | ● | ● | ● | ○ | ● | ○ | ● |
| Graphics and presentation | ○ | ○ | ○ | ● | ○ | ● | ○ | ○ | ○ | ● |
| MS Office integration | ○ | ○ | ○ | ● | ○ | ● | ○ | ● | ○ | ○ |
| **Social software** | | | | | | | | | | |
| Wiki | ● | ○ | ○ | ● | ● | ● | ● | ● | ● | ● |
| Weblog | ● | ○ | ● | ● | ● | ● | ○ | ○ | ○ | ○ |
| Social tagging | ● | ○ | ● | ● | ● | ● | ○ | ○ | ○ | ○ |
| Social bookmarking | ● | ○ | ● | ○ | ○ | ○ | ○ | ○ | ● | ● |
| Social cataloguing | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Social presence | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ |
| Tracking | ● | ○ | ● | ● | ● | ● | ● | ● | ● | ○ |
| Rating | ○ | ○ | ● | ● | ○ | ● | ● | ○ | ○ | ○ |
| **Connection** | | | | | | | | | | |
| People profiling | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| People search | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● |
| People tagging | ○ | ○ | ● | ● | ● | ● | ● | ○ | ○ | ○ |
| Networking services | ○ | ● | ● | ● | ● | ● | ● | ○ | ○ | ○ |
| **Rating** | 67,00% | 52,50% | 69,00% | 93,00% | 70,00% | 85,00% | 57,00% | 63,75% | 53,00% | 62,50% |

Collanos offers a well integrated standard set of features for document management. The organization of not only documents, but all sorts of content in a folder structure, appears to be the dominating part of the system. However the synchronous editing of documents is not supported. In Collanos team members can be informed about changes or tasks via instant messages and the status of the team members is displayed in the workspace. Nevertheless, the support of social software features like wikis or blogs is somewhat limited. Looking at connection features, Collanos provides profiles of the team members, search for experts on certain topics and some social networking services.

Jive´s strength is connection. It offers many features for building employee communities using social networking

concepts. Personal information about authors can be found throughout the entire collaborative content environment. Jive is a technologically mature platform rated by Gartner [12] as one of the market leaders.

Microsoft® SharePoint Server 2010 provides a wide range of features for content sharing and management. In combination with Microsoft® Office 2010 the editing of any office document by several users at the same time is possible. While editing the document together, one can see which user is editing which part of the content. If two users try to edit the same piece of text, the user who started editing later gets a warning that this part of the document is currently edited by another user. In combination with the social presence feature, an image as well as contact details of the other user are displayed and it is possible to contact this user via instant messaging. Thus, SharePoint 2010 is the only E-Collaboration system that offers real integration of synchronous collaborative working on content. Another feature of SharePoint 2010 is that Microsoft® Office documents can be created directly out of the shared workspace. While many platforms only support up- and download of documents but no editing on the platform, some, like Liferay, provide editing of Microsoft® Office documents, which were initially uploaded to the platform. As all analyzed E-Collaboration systems are web-based, creating some wiki like webpage out of the workspace is offered by all systems. However, we wanted to focus on creating and editing various kinds of documents and not only web pages using an editor. Even though SharePoint 2010 supports almost all features that were identified to be relevant for core collaboration, the effort to set up the system and integrate all functionalities must not be underestimated.

Socialtext offers an intuitive user interface combined with a lot of functionality that is highly integrated into the features offered by the system. The main focus of Socialtext is on the social aspect by transparently connecting people with the corresponding content. It offers new features like microblogging via so called Socialtext signals, which also allows for following the colleagues´ activities like using Twitter. With the help of an activity stream it is possible to see what the other team members are doing at the moment, like the status on Facebook. Groups can be created for projects, functional groups or communities of interest.

Liferay offers social tagging for web content, documents, messages, board topics etc. in order to organize and share content with other team members. Activities on, e.g., blogs, message boards, wikis can be tracked via a recent activity portlet on a Facebook-like activity wall.

PBWorks allows for sharing activities and tasks via the personal profiles of the team members and to follow users to see what they are doing. PBWorks offers a smooth integration of comments, microblogs, messages and information on the authors with the content. The synchronous editing of pages is provided by inviting the users who are allowed to contribute via chat. Thus, it is possible to edit the content of pages together and communicate about the changes via instant messages.

Huddle is a simple and easy to use E-Collaboration system that offers well supported content sharing and management with integration of Microsoft® Office. The set-up of Huddle is fast and easy, the user interface intuitive. Huddle can be recommended for small teams that want to start collaborating right away, having no special requirements. A shortcoming of Huddle are social aspects and features for connecting people and content.

EGroupware supports many project management features and also offers special functionalities for software development projects. However, when it comes to the support of core collaboration EGroupware offers only parts of the crucial collaboration features. The social aspect is not a strength of EGroupware and the connection between content and people is not as transparent as in Liferay for example. Even though EGroupware seems to have been developed for the collaboration in software development projects, it is easy to use and provides some other collaborative features apart from project management.

Simple Groupware is another open source groupware and content management software with distinct collaboration features. Simple Groupware provides many features for asynchronous content handling, including content creation and editing within the workspace. Content can be collaboratively managed in enterprise, project and personal spaces. However, Simple Groupware lacks some social software elements (especially tagging) and networking features and has shortcomings in usability.

## VI.  DISCUSSION

The presented results in Table II are derived from a number of E-Collaboration systems with above-average collaboration emphasis. However, significant differences in extent and quality of collaboration support can be detected.

As Table II shows, most E-Collaboration systems support collaboratively creating and managing content (especially documents or text, tags, bookmarks, people) in an asynchronous way. Asynchronous document handling for different kinds of documents – including versioning, check-in/check out, etc. – is well supported by all products (without going into details on the grade and quality of the implementation).

However, synchronous features, i.e. synchronous real-time editing, is provided only in rare cases, although nameable authors especially in the CSCW community regard synchronous functionality or concurrency as core aspects of electronic collaboration [13][16]. Only one system (Microsoft® SharePoint Server 2010) provides real-time synchronous editing facilities in certain setups. Another product offers a virtual whiteboard (PBWorks), but the others do not include synchronous editing at all.

E-Collaboration systems have benefited a lot due to the widespread use of social software and gained significant momentum throughout the last years. They introduce new options and functions to electronic collaboration and help to

distinguish E-Collaboration systems from related CSCW systems and groupware. Modern E-Collaboration systems include typical elements of social software, like wiki, weblog, social tagging and social bookmarking, and these elements can be found in many E-Collaboration products. Nevertheless, significant differences can be identified in the utilization of social software elements. 8 out of 10 E-Collaboration systems implement a wiki, but only 5 systems include a weblog. Social tagging is provided by 5 E-Collaboration systems and social bookmarking is offered only by 4 out of 10 systems. Remark: These numbers are not representative for the entire group of E-Collaboration systems as defined in Section III and a percentage of social software utilization cannot be derived from these numbers.

Social presence and connectivity features have been included in the evaluation, although they actually make up a separate type of social interaction according to the 4Cs model (derived from the classical 3Cs of CSCW, extended by Connection), as they are highly important for modern E-Collaboration approaches. The reviewed systems provide sufficient support of connection features: 9 out of 10 systems possess social presence functionality and all offer personal profiles and people pages. Complex social networking services, as they are well-known from specialized social networking sites, are provided by 6 of 10 products. People tagging features are offered only by 4 products.

Substantial differences can be found in creating documents out of the shared workspace. Only a small number, 3 respectively 5 E-Collaboration systems offer this functionality for multiple kinds of documents (i.e., files) besides creating integrated, web page-based content.

## VII. Conclusion and Future Work

We can identify quite differing degrees of collaboration support among the reviewed E-Collaboration systems. All reviewed products offer considerable support of core collaboration functionality. However, the focus of the systems is on asynchronous collaboration and the E-Collaboration systems marketplace lacks support of synchronous collaboration tasks in teams – notably synchronous real-time editing tools. To cover the entire spectrum of possible needs in E-Collaboration (i.e., core collaboration requirements) more options for synchronous cooperation should be provided. The evaluation of the reviewed systems educes that several systems might benefit by more complete offerings of social software technologies.

The presented features are used to compare E-Collaboration systems according to their true coverage of collaboration activities in a standard team collaboration scenario. These features and corresponding weights can be used as a basis of decision-making when selecting an E-Collaboration system but have to be refined for a specific collaboration situation. The results presented in Section V and VI can be broken down to provide more precise results. The evaluation in Table II included only ratings on a binary scale based on Boolean values (implemented ● or not ○). Future work will provide more detailed ratings on a scale of 0 to 4 and the accumulated criteria presented in Table II will be specified in more detail to be able to differentiate between products. Due to space restrictions we presented the evaluation of only 10 products of the 50 identified complete E-Collaboration systems.

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