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User Requirements for a Web Based Spreadsheet-Mediated Collaboration

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ABSTRACT

This paper reports the initial results of a research project to investigate how to develop a web based spreadsheet mediated business collaboration system that could notably enhance the business processes presently carried out by Small to Medium sized Enterprises. Using a scenario-based design approach, a set of user's requirements were extracted from an appropriate field study. These requirements were then analysed in the context of well-known usability principles, and a set of design implications were derived based on a selected set of HCI design patterns related to cooperative interaction design. Starting from that knowledge, suitable interactive collaboration scenarios have been drawn, from which a list of user interface requirements for a web based spreadsheet mediated collaboration system has been formulated.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces And Presentation**]: Group and Organization Interfaces – *Computer-supported cooperative work, Web-based interaction, Synchronous interaction* . H.5.2 [**Information Interfaces And Presentation**]: User Interfaces – *User-centered design.*

General Terms

Design, Human Factors.

Keywords

Artifact mediated collaboration, scenario-based design, usability principles, HCI design patterns.

1. INTRODUCTION

In the context of Small to Medium sized Enterprises (SME), we are still witnessing many difficulties to the transformation of business processes by means of the advanced information technologies that are available in this era. The process of migrating from traditional activities towards IT-supported activities, known as *eTransformation process*, is in fact slowed down by several practical issues which small organizations have to face in order for the process to be effective [7]. The small size and the limited human and financial resources, which usually characterize SME are one of the main obstacles to making business processes more effective by using appropriate information and communication technologies. Nevertheless if a cost effective solution can be found which is both easy to use and maintain then these organisations will benefit immensely.

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We conducted a field study involving 5 SMEs operating in the Western Sydney Region of New South Wales (NSW), Australia. The study revealed that all the companies mainly used spreadsheets to store information and track their project progress. Since the introduction of the first computerized spreadsheet, VisiCalc, in 1979, the adoption of spreadsheet applications has been continuously increasing in different domains, and is today recognized to play a central role in the evolution of work systems. Grossman and colleagues conclude from their research on the use of spreadsheets as an effective software development platform that 'spreadsheets are vitally important to business, and merit sustained research to discover techniques to enhance quality, productivity, and maintainability' [5]. Spreadsheets are easily customizable. Most of their functions can be used by any basic user with very little training. Large amounts of data can be accessed at once, complex analyses can be performed on different types of data and multiple real time visualizations can be created in a seamless way.

The main problem that we found in our interviews was when the employees had to share the spreadsheet with co-workers to perform a business process that was not easy. Typically people emailed the spreadsheet to one another or saved it onto a network drive which everybody can access. If the spreadsheet was shared via emailing it to one another people had a difficult time keeping information in various copies of the spreadsheet the same. If it was on a network drive easily implementing appropriate access control was a problem. In either case it was not possible to keep a record of the revision history of the spreadsheet which is often required by the businesses.

Web provides an ideal way to share information among many people with appropriate access control mechanisms. Because of this today many software applications are migrated to the web. Thus we started this research project to investigate how we can develop a web based spreadsheet mediated business collaboration system that could notably enhance existing business processes while retaining all the positive features of standalone spreadsheets that are extensively used by businesses.

Since usability is a major concern in the adoption of software tools, especially in small industrial contexts, we decided that usability issues should be addressed from the early stages of the iterative development process we were undertaking, so as to promote the effective use of our system.

The design process we started is inspired by Rosson and Carrol's scenario-based design method [9]. Scenarios of usage were in fact chosen as our primary design objects, because of their simultaneous ability to guide design and to facilitate usability evaluation and assessment during the iterative development process.

The rest of the paper is organized as follows. In Section 2 we describe the fieldwork conducted with 5 SMEs and make some initial considerations on the observed activities. In Section 3, we describe suitable scenarios of working practices capturing the knowledge acquired from the observation, and formalize the derived user requirements. In Section 4, we describe the design implications derived from the application of the selected cooperative interaction design patterns. In Section 5 we describe three categories of specific functionalities that we discovered as a result of this study the user interface of a web based spreadsheet mediated collaboration system needs to feature. In Section 6 some final remarks are made.

2. THE FIELD STUDY

The preliminary activity we performed for our field study consisted in a survey on the use of spreadsheet applications conducted among people with different backgrounds and operating in different application domains. The 16 subjects who took the survey were from business sectors, management sectors, finance and accounting sectors, and educational sectors. All of them were intermediate to advanced users of spreadsheet applications. The main goal of the survey was to derive appropriate inquiry templates we could use during the contextual investigation that was scheduled as successive step of our fieldwork. We therefore posed questions to subjects on the kind of activities they commonly perform with spreadsheet applications and on the extent to which spreadsheets sharing is involved in their activities. The kind of activities ranged widely, from simple data storage, data analysis and statistics, data tracking, simulation models representations, charting and graphing, automation through scripting languages, to business logic construction and applications creation. The rationale behind the choice of a spreadsheet application for the kind of activities they mentioned was, for most of the subjects it was an application of a *de facto* standard, but some of them also declared to be following their organization rules. The frequency of usage of spreadsheets was medium to high, though mainly limited to specific activities of everyday work.

Analysing the survey results, we were able to set up the right investigation thread for the contextual inquiry and observation that followed. We identified a group of 5 SMEs operating in the Western Sydney Region as interesting subjects for further observation. In fact, the collaborative nature of some of their usual activities accompanied with a minimal or non existence of information technological support to such activities, turned out to be the right context of study for our research. The 5 SMEs were selected out of a cluster of 30 companies taking part in a wider project carried out at UWS, meant to provide a methodological roadmap for cost-effective "eTransformation" of Small to Medium Enterprises [7].

Four of the selected SMEs were small companies, which operate, respectively, in the areas of boat cruises, interior supply, building construction, and financial services. The fifth one was a no-profit company, mainly relying on government funding, set up to develop and deliver training programs for unemployed people. As explained above, the goal of this fieldwork was to depict scenarios of established work practices, from which user's requirements could be derived for a spreadsheet-mediated collaborative web environment. The informal interviews performed *in situ* allowed us to gain a comprehension of collaborative activities requiring the use of spreadsheets, as they really occur in small working environments. For each company, we observed:

- the physical settings in which collaborative activities using spreadsheets are performed (e.g., whether co-located or distributed offices are involved),
- the means by which those activities are usually coordinated (e.g., whether in a face-to-face manner or by telephone/computer mediated communication),
- the means by which one participant make aware other co-workers of the actions he has performed to get the activity done (e.g., by explicit notification or letting information on those activities to be sought on the shared spreadsheet).

As a result of our study, we were able to understand that spreadsheets are intensively used for crucial management activities by almost all the interviewees. However, in most cases, collaboration happens by means of written annotations on spreadsheets printouts, with very few exceptions in the use of online spreadsheets, provided for reading access only. To get a feel of the real situation, we enquired the interviewees about the work activities they usually perform with spreadsheets and about problems occurring with the physical, rather than digital, sharing of such artifacts. We thus gained useful insight of the obstacles which appear to hinder the full exploitation of the powerful functionalities of spreadsheet applications, in the context of small organizations. Indeed, the major problem turns out to be the small size and the limited human and financial resources, which usually characterize SMEs. Although all the interviewees recognized that great benefits would come to their business process from the adoption of a web-based collaboration environment for their spreadsheet sharing activities, their major concerns were related to the cost of this technological evolution within their small organization. Their main expectations from the new environment were:

- Low training cost – the overall enhancement of the business process should be gained with little learning effort
- Low maintenance costs – the company should be able to easily maintain the system, once it is deployed, with no need for developers' intervention.

The latter considerations were precious hints to the formulation of the user requirements that our environment should fulfill.

3. FROM PROBLEM SCENARIOS TO USER REQUIREMENTS

In order to formalize the requirements elicited from the interviews, we capitalized the knowledge gained from the fieldwork and envisaged some scenarios of working practices, from which we could start our brainstorming activity for the design of a possible solution.

Analysing the different typologies of users we observed during our fieldwork, we were able to build some *personas*, who could represent the archetype users of our web-based environment, and, to envisage their tasks inside representative interactive collaboration scenarios.

The study of collaboration scenarios of existing working practices gave us the opportunity to reason about the major user requirements that emerged from the field observation carried out among the five SMEs.

In fact, the first general requirement that all observed collaboration activities seemed to rise (as it is also described in the previous scenario) was the need for higher efficiency in the collaboration activities carried on spreadsheets. Therefore some innovative technique is highly desirable to enhance the business processes to which those activities are related.

However, besides an encouraging confirmation of the usefulness of our work, we were interested, at this stage, in deriving a formal list of user requirements that we could take into account throughout the design process. Summing up all the considerations and discussions we had upon the fieldwork completion, and reasoning on the derived scenarios, we were therefore able to elicit an initial set of 5 user requirements:

- ***UReq 1*** *Little training effort*. The system should be easy to learn.
- ***UReq 2*** *Low external costs for maintenance activities*. Any modifications to the business activity should be easily translated into modifications to the online spreadsheet application.
- ***UReq 3*** *Preservation of existing privacy and data access rules*. Privacy and data access rules actuated so far should be preserved in the new system, assuring suitable separation of concerns and privileges.
- ***UReq 4*** *Appropriate synchronization policy among users*. Concurrent accesses and modifications to the same portion of a spreadsheet should be adequately ruled.
- ***UReq 5*** *Versioning control*. Detailed modification loggings should be devised at cell level, so as to keep track of *who* modifies *what* in the spreadsheet.

4. SPREADSHEET MEDIATED COLLABORATION

These initial requirements were further refined by adaptation of existing cooperative interaction design patterns to spreadsheet-mediated collaboration as the next step in our design process.

The success of the pattern approach witnessed after the seminal work by Christopher Alexander et al. in 1977 [1], in the architectural domain, has led researchers in HCI to conceive it as mostly appropriate to user interface and interactive system design [10, 2, 3]. Several pattern languages have been introduced in the last decade, as *lingua franca* [4], by which not only are the interface designers able to share their expertise with one another, but also an effective 'user-centered' design process can be carried out, thanks to a clear and formal documentation of the design choices, which can be provided with system end-users and general stakeholders, in order to receive their feedback.

We searched the literature on existing HCI patterns, with the aim to gain guidance for our design process, and make all necessary decisions to realize the shift from the traditional, asynchronous sharing of spreadsheet based work to on-line spreadsheet mediated collaboration, while addressing the usability issues that resulted from the analysis of user requirements. Among the several families of design patterns proposed in the area of human-computer interaction, we found especially helpful for our research the interactive collaboration patterns, described by Martin and Sommerville [8]. The patterns, which were derived from other, quite different, settings, are used here to gain a better understanding in the domain of spreadsheet based collaboration. In fact, combining the analysis of such patterns with the considerations drawn from our fieldwork, we were able to select a subset of 6 patterns and the design implications listed below, which could be fruitfully exploited for the design of a web spreadsheet-mediated collaboration environment.

1. Pattern 'Artifact as an Audit Trail'.

Design implications: - There should be a means by which changes to the spreadsheet can be tracked and this should go down to the cell level so that cell to cell changes can also be seen. A revision history of all the changes made would be beneficial in this case.

2. Pattern 'Public Artifact'

Design implications: - A common notice board should be designed allowing each participant to gain an overall view of the collaboration activities which are being performed on the spreadsheet.
- This commonplace could also be a good design solution for the aforementioned revision history.

3. Pattern 'Multiple Representations of Information'.

Design implications: - To what extent should the paradigm *WYSIWIS* (What You See Is What I See) be realized? Flexible choices should be provided. The interface could be made user-adaptive, so that each participant may dynamically choose either to synchronize his view with the others or to browse the spreadsheet as he needs.
- The revision history should be viewed only on demand, so that the user is not overwhelmed with unnecessary information displayed on the interface during his usual activities.

4. Pattern 'Accounting for an Unseen Artifact'.

Design implications: - The interface should allow for *deictic* communication. Synchronized input pointers to the spreadsheet could be an appropriate solution for those situations where direct communication among participants is needed in reference to specific portions of the shared spreadsheet.

5. Pattern 'Working with Interruptions'.

Design implications: - As for the issue of managing interruptions, collaboration awareness also implies that when one participant is interrupted by external events, the environment should notify his temporary absence to other participants, as well as his return back to the activity (e.g., an idle/busy flag displayed on the collaborative interface).

6. Pattern 'Collaboration in small groups'.

Design implications: - Appropriate feedthrough should be provided, so that any participant is able to see the effect of others' actions on the interfaces. As an example, a color change in a cell could indicate that the cell has just been updated. Similarly a lock flag could be used to indicate the portion of the spreadsheet

which is currently being modified by some participant, and for which writing privileges are temporarily disabled to others.
- The system should be flexible enough to allow the results of a single user activities to be shared with others (e.g., knowledge acquired from personal analyses of the spreadsheet data).

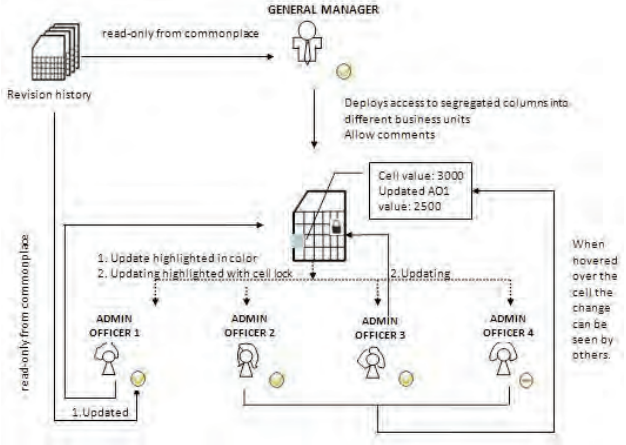

Figure 1. A spreadsheet mediated collaboration scenario.

5. USER INTERFACE REQUIREMENTS

The brainstorming activity that followed the analysis of the identified user requirements and the consideration of the design implications coming from the selected patterns, allowed us to draw a suitable set of collaboration scenarios that the target web environment should provide. Figure 1 depicts one of such scenarios, which captures essential aspects of the spreadsheet mediated collaboration, namely: the participants, their individual status (*idle* vs. *busy*), the feedthrough (the dashed arrows in the figure) gained by locking cells during modification and by highlighting cells after modification, and, finally, the observability of the overall collaboration process by means of a revision history associated with the shared artifact.

As a result, we were able to prepare an initial list of specific functionalities that the user interface of our web based spreadsheet mediated collaboration system should feature. Due to space limitation we cannot describe each user interface requirement in detail. We will only mention the three broad categories;
a) collaboration environment awareness,
b) overall collaboration process analysis, and
c) operations on the artifact.
The first category comprises all the functionalities that allow collaboration awareness issues to be properly addressed by the environment, both during synchronous or asynchronous collaboration through a spreadsheet. The second category focuses on the spreadsheet artifact itself and on some important parameters that would better support individual backward exploration as well as recoverability during the overall business process. Finally, the third category includes all the functionalities that would allow the spreadsheet artifact to be effectively manipulated by multiple participants through the web environment, in terms of either data updating or structure modification.

6. CONCLUSIONS

In recent years several web based spreadsheet applications have been developed with the aim to exploit the data sharing and collaboration capabilities through distributed manipulation of spreadsheets within complex organizations (see, e.g., [6, 11]). Review on existing online spreadsheets proves the emerging need to provide tools by which cooperative activities on spreadsheets could be effectively performed. Summarizing from our analysis of commercial online spreadsheets, we realized that a common limitation is that usability issues have not been adequately addressed when conceiving the transformation of spreadsheets from single user to multiple user application. This is in fact the reason why none of those systems have been widely adopted so far by organizations which use spreadsheets for complex collaborative activities, while their use is mainly limited to simple list maintaining activities and to multiple user read-only access.

In this project through systematic analysis of real life usage scenarios, usability issues and design patterns we have formulated a set of requirements that a user interface should provide to support effective spreadsheet mediated collaboration. When we compared existing web based spreadsheets against these requirements we discovered that these fall short of satisfying most of these requirements. Thus the next step in this project is to create a prototype of a system that will meet these requirements, test it again with actual users and then evolve it to obtain the full system.

7. REFERENCES

[1] Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., Angel, S. *A Pattern Language: Towns, Buildings, Construction*. Oxford Univ. Press, Oxford. 1977.

[2] Bayle, E., Bellamy, R., Casaday, G., Erickson, T., Fincher, S., Grinter, B., Gross, B., Lehder, D., Marmolin, H., Potts, C., Skousen, G. & Thomas, J. “Putting It All Together: Towards a Pattern Language for Interaction Design”. *CHI '97 Workshop*. SIGCHI Bulletin, ACM: January, 1998.

[3] Borchers, J. *A Pattern Approach to Interaction Design*. Wiley.2001.

[4] Erickson, T. "Lingua Francas for Design: Sacred Places and Pattern Languages." In *Proc. DIS 2000*. New York: ACM Press, pp 357-368. 2000.

[5] Grossman, T.A., Mehrotra, V., Özlük, Ö. “Lessons From Mission-Critical Spreadsheets”, Comm. of the Association for Information Systems, Vol. 20, 2007, pp. 1009-1042.

[6] EditGrid. *ThinkFree*. http://www.editgrid.com/explore/. user/mcpaige/EditGrid_v._ThinkFree.

[7] Hol, A., Ginige, A. “eTransformation Journey for SMEs.” *Int. Conference on e-Business*, pp. 115-120. 2009.

[8] Martin, D., Sommerville, I., “Patterns of cooperative interaction: Linking ethnomethodology and design”, in *ACM -TOCHI*. v.11 n.1. pp.59-89. 2004.

[9] Rosson, M.B. & Carroll, J.M.. *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. San Francisco, CA: Morgan Kaufman. 2002.

[10] Tidwell, J. *Common Ground: A Pattern Language for Human-Computer Interface Design*. at http://www.mit.edu/~jtidwell/common_ground.html, 1997.

[11] *First impressions of Google Spreadsheets*. http://www.badlanguage.net/first-impressions-of-google-spreadsheet.