EVALUATION OF A VIRTUAL CAMPUS: BELL UNIVERSITY LABS

by

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ABSTRACT

Virtual communities are established to facilitate non-collocated collaborative work. Usability evaluations for single-user applications are insufficient to evaluate virtual communities. The evaluation method have to assess the usability of the interface as well as the effectiveness of group communication.

This thesis presents an evaluation methodology to improve the infrastructure and participation of virtual communities. Three evaluation studies on the Bell University Labs website were used as a framework for evaluation. The studies discovered that the participation of the website was low, members used the website as a file sharing space, and there were usability and functionality problems in the website. Three types of user profiles were identified: one type with negative attitudes, a second type with different views on different components, and a third group with neutral opinions on the website. Suggestive steps for the user interface redesign and the evaluation methodology are recommended.

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CHAPTER 1

INTRODUCTION

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1 INTRODUCTION

Individuals are no longer doing business or research solely in closed environments; there is increasing use of global networks. Businesses and researchers want to stay competitive by forming alliances. These partners are often from different organizations and may be located in different geographic regions. Such an alliance is often difficult to integrate; new kinds of tools and processes are needed to facilitate such collaboration. Similarly, people in different departments within an organization are often separated. They may be located in separate buildings, campuses, or even cities. These people, located separately and with different schedules, have difficulty meeting physically. Extra time must be allocated for these meetings since travelling is often required by much of the group. Moreover, there is usually not enough version control in key documents, causing duplication of work or delay in work progress. Thus, there is a demand for collaboration at a distance, which requires a medium for connecting with others. For example, the more traditional telephone, radio and TV connect people at a distance by carrying messages from one party to another. The message communication method is typically highly structured, and it follows a predetermined route (Brinck, 1998). Other technology can also take advantage of this structure to improve communication. This process is termed "technology mediated communication".

Technology advances including the Internet accelerate the trend of moving office space to virtual (i.e., online, network, cyber-) space, thereby organizing community networks. Many computer users have networks with high bandwidth and fewer constraints, making communication via the Internet possible and reliable. Virtual communities that can be accessed through the Internet are advantageous for people wanting to communicate and collaborate at a distance. The space allows groups to make schedules, plan proposals, and present deliverables and other documents to the rest of the group. Individuals gain a sense of belonging in the relationships that jointly define group membership. These virtual communities provide an environment where people can work separately while feeling mutually close. In this thesis, a virtual community is defined as a technologically mediated, persistent environment that supports multiple interaction and multi-user engagement (Mehlenbacher *et al*, 1994).

2 RESEARCH MOTIVATION

Virtual community is another form of group collaboration. Support for group collaboration has been of interest to the research community (Mynatt *et al*, 1997). Virtual communities gather researchers in a single virtual workspace to work, but do the virtual communities enable effective collaboration? What are the parameters for collaboration effectiveness? Different work groups each have unique cultures. Thus, each group should have its own personalized virtual workspace to promote useful information flow. For example, different types of multimedia interfaces will be required for various personalized versions of the workspace to support diversity online. Moreover, even if a virtual community has been built, will researchers use it and *continue* to do so? This question leads to interesting issues of actual usage duration, and of the amount of activity that virtual community participants carry out over time, i.e., issues of longevity and stickiness. Sociologists have been studying physical communities to quantify relationships within groups. It is not well understood how these theories could transfer to virtual communities (Brown *et al.*, 1999). Studies are required to discover what kind of attributes from physical communities can be applied to their virtual counterparts. From the review by Pinelle & Gutwin (2000), almost a third of groupware systems were not evaluated formally. Even then, only a quarter of the evaluations involved a practical setting in which a variety of evaluation techniques were used. This thesis focuses on how to evaluate the usefulness of features in virtual communities that are built to facilitate research collaborations. The evaluations should help to guide subsequent improvements in the virtual community's infrastructure and its participation rate.

3 RESEARCH QUESTIONS

Evaluation of virtual communities is required to build successful systems over time. Usability evaluation is required to evaluate participants' preferences within virtual communities and their effectiveness in improving collaborative work.

Some questions that need to be considered are:

- What kind of infrastructure for virtual communities can enhance collaborative work?
- What methodology is required to effectively evaluate these virtual communities?
- What kinds of features or components in a virtual community should be evaluated to test its effectiveness?

4 THESIS GOALS AND OBJECTIVES

The objectives of this thesis can be grouped as follows:

- To determine if the selected virtual community is easy to use and meets users' expectations
- To discuss how to evaluate a virtual community infrastructure
- To explore how the evaluation methodology can be extended to help build a successful virtual community
- To devise an improved methodology to enhance designing of a new virtual community, by considering how best to evaluate a virtual community
- To make design recommendations for the selected virtual community

5 THESIS OVERVIEW

This thesis claims that both usability and social issues are important in developing a successful virtual community. A methodology that properly evaluates a virtual community should include inspection criteria for both usability and social issues. The evaluation results provide leads to components that should be personalized, thus helping to motivate users to use the virtual community.

Chapter 1 introduces the thesis topic and the goals and objective of this thesis. Chapter 2 provides background information and a review of virtual communities. Chapter 3 presents the existing virtual community in question and the methodology used to evaluate it. Chapter 4 describes the user study, and the results of the study are then analyzed and discussed. Chapter 5 recommends improvements to the user interface of the Bell University Labs website and to the evaluation methodology. Chapter 6 concludes the thesis by summarizing the significance of the results of the user study and then outlining directions for future research.

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2: LITERATURE REVIEW

Since this thesis claims that usability issues, social issues and stickiness affect the success of virtual communities, and that evaluation and personalization help to minimize failure, the following literature review chapter will begin by providing an understanding of the attributes and components of virtual communities. A review of existing virtual communities is made to understand the purposes of virtual communities. The concept of stickiness is discussed. The chapter then presents different methods of evaluation that will form the basis of a revised methodology used to evaluate virtual communities. Finally, the basis of personalization is introduced.

1 VIRTUAL COMMUNITIES

The terms groupware, collaborative environment, and virtual community are often used to describe similar functions. Groupware is a general term to describe the software or environment where people work together through computer systems in a shared workspace (Gutwin & Greenberg, 2000). Similarly, collaborative environment is where "users co-operate in order to perform a task" (Steed & Tromp, 1998). Virtual community has the above functionality. In addition, virtual communities provide the users a sense of community, where people can use them both for work and leisure discussions. The following section will summarize some common definitions for virtual communities by other researchers.

1.1 What are virtual communities?

Howard Rheingold (1993) defined virtual communities (VCs) as "social aggregations that emerge from the Internet [where] people carry on public discussions long enough and with sufficient human feeling to form webs of personal relationships in cyberspace". Group activities in VCs include playing games, making friends, discussion groups, and pooling resources. The VC can be used as a place for social events, education aid, and work/research assistance. This thesis focused on VCs that are used by researchers.

Most VC research focuses on highly text-based virtual environments (e.g. Schiano & White, 1998; Mehlenbacher *et al*, 1994; Mynatt *et al*, 1997); however, there are a wide range of environments that can be considered as VCs. Some examples of virtual communities are a Bulletin Board System (BBS), Internet Relay chat (IRC), Multi Users Virtual Environments

(MUVE, or more commonly MUDs and MOOs), and other collaboration software involving some text, graphics, and/or other media.

A BBS is like a physical bulletin board, but built electronically. A BBS contains several electronic bulletin boards for discussion of material of interest or announcements. The interaction in the BBS is not real time; members belonging to a certain group post messages similar to a form of group email to the 'board' and wait for a reply.

IRC allows a group of people to communicate and interact through their computers at the same time. It can be thought of as a giant conference phone call. Instead of hearing the other person's voice, however, messages are exchanged by typing them into a shared window (Maher, Skow, & Cicognani, 1999).

MUVEs are collaborative computer environments in which participants navigate and communicate in a virtual environment. They are represented by a certain character and use this identity to function in the virtual environment. MUVEs facilitates persistence of environment for interactions by presenting a persistent meeting room. Interaction can be synchronous one to one, one to many, or many to many communications. Multi-User Domains (or Dungeons), i.e. MUDs are one form of textual MUVE, and typically associated with multi-user games. MUDs Object-Oriented (MOO) are another version of MUDs, and are typically associated with social communities or education environments.

Virtual workspace allows people to work separately while still experiencing a mutual sense of presence. For example, the workspace allows individual members to be 'seen' by other members of the group. Members can provide extra information, such as a web site, email address, and research interests, for other members to see. Communities contain individuals who form relationships, and who have a sense of group membership and belonging within their group (TechTarget, 1999). VCs are often constructed to utilize not only regular net tools like email, ftp and the web for posting and reading of communications, but also some type of real time communication environment. In this work, a VC is defined as a technologically mediated, persistent, environment which supports multiple interaction styles, a capability for real time interaction, and multi-user engagement (Mehlenbacher *et al*, 1994).

McLaughlin, Osborne, & Smith (1995) argued against using the term 'community' to describe the type of virtual 'community' that computer-mediated communication created. They believed the use of the community metaphor to describe the social aspect is inaccurate, since 'community' may refer to a network of strangers exchanging information or a group of virtual friends having a discussion. In addition, Baym (1998) questioned the ability of the on-line 'community' to substitute for off-line community in any meaningful way. Even though Schuler (1996) was enthusiastic about creating new forms of communities. he questioned the potential for computer mediated communication to reproduce 'real' social relations in a 'virtual' medium. Others (e.g., Blanchard & Horan, 1998; Rheingold, 1993b) assumed that virtual communities are 'real' communities. Rheingold (1993b) suggested virtual communities could be viewed as real communities or pseudocommunities, or they might be something entirely new in the realm of social contracts.

Walls (1993) viewed online networks as "virtual groups" and "virtual communities" where networked sources of information, ideas or other forms of enrichment are provided for participants belonging to "real" group communities for whom face-to-face relationships are primary. Face-to-face communities, linked through task-focused online networking across geographical, political, and cultural boundaries, can preserve the interests of face-to-face communities. These virtual networks are built to support the goals and relationships of real communities, which are complementary to the social networks in those communities.

Roberts (1998) defined community by the following dimensions, rated by Newsgroup participants across a variety of groups: cohesion, effectiveness, help, relationships, language and self-regulation. Cohesion relates to group identity and members' sense of belonging. Effectiveness is how much the group has an impact on its members, both on line and off line. Help indicates how helpful the group is when its members ask for assistance. The relationship dimension reflects the extent to which group members will form individual relationships with other members. Language checks if there is any specialized jargon of the group. Self-regulation is how well the group can control its policies. The community should have a feeling of belonging and a sense of closeness. The study suggested that the amount of time and effort participants spent in the community is in proportion to their satisfaction with the sense of community.

Durlacher Research (Marathe, 1999) identified four principle types of communities online: communities of purpose, practice, circumstance, and interest. Communities of purpose are those where people gather to achieve a similar objective. These communities have a functional purpose, which will provide an added value for users. Communities of practice involve people sharing the same profession, situation, or vocation. Their professional bond builds networks of relationships that may be translated into commercial value. Similarly, people in communities of circumstances also build networks, but by their position, circumstance, or life experiences, not by their profession. These communities are more personally focused and built around life stages. The fourth type is communities of interest, where people exchange ideas and thoughts about a common interest or passion.

Blanchard & Horan (1998) distinguished two different types of online communities. One involved the traditional sense of a physically based community enhanced by electronic resources; the second type was a geographically dispersed community that shared a common interest. They argued that physically based communities have the potential to increase social capital more than geographically dispersed ones. These two types of communities carry a different type of relationship, and could be in competition. Virtual communities that have both computer-mediated and face-to-face communication have a stronger sense of community because much of the online contact is between acquaintances and real-life locals, and it is easier to disrupt online only relationships (Blanchard & Horan, 1998; Wellman & Gulia, 1999; Schuler, 1996). Blanchard & Horan then proposed the linking of the physical based and interest based communities by creating a new type of virtual community form in which a new "space" is available for people to interact with their physical and virtual neighbors.

1.2 Review of existing online communities

The above section defined what VCs are. The definition provided background fundamentals of VCs. This section will explore some VCs which are in use, to apply the fundamentals to real life situations. The pros and cons of each system are identified. Factors and issues that other researchers discovered through their own implementation of VCs can help to improve the development of future VCs.

One of the oldest and largest online communities in used today is LambdaMOO (Schiano & White, 1998). This is a typical social MUD. Schiano and White performed research on the social interaction in LambdaMOO, aimed to characterize aspects of "life in LambdaMOO". Their

research methods included an online survey, personal interviews, and system data logs. Schiano and White concluded that the social interaction in MUDs and MOOs was a strong focus and users had better interaction skills with increasing experience. Their findings suggested that social interaction must be a focus when designing virtual spaces, which should provide a strong sense of place.

North Carolina State University built an education MOO called TechComm-VC for use in composition and technical writing courses (Mehlenbacher *et al*, 1994). When this environment was tested in a classroom environment, its "multiple interaction styles" were not sufficient. Technical communication students and practitioners using the MOO criticized it as time-consuming and exhaustive when typing in text. They also had difficulties in following overlapping and multiple conversations. Moreover, the tool did not support WYSISYG manipulation of text, since the MOO worked only with ASCII text. Even with these shortcomings, Mehlenbacher *et al*'s survey data supported the benefits the student-teacher collaboration added by their MOO environment.

Mynatt *et al* (1997) used several MUDs as examples to describe collaboration in network communities. They used Pueblo and Jupiter -- the MUDs used at PARC and EuroPARC. These virtual communities required a sense of shared space which had flexible boundaries for various levels of interaction and awareness such that the users could move easily from the physical world to the virtual world. The network communities were intended to allow learning opportunities for members to bridge the gap between the social and technical systems.

Koku, Nazer, and Wellman (1999) recently studied a group of researchers in the early stages of building both a physical and a virtual community, and was referred to by the pseudonym "Technet". Technet was a multidisciplinary research organization that relied on personal relationships between researchers, various seminars, and social events to create cohesion and a sense of community. In addition, there was ongoing work in Technet to develop a virtual community through the development initially of a Website and ultimately of a suite of functionalities within a collaborative workspace, or "Virtual Campus". In their interviews, members stated that they found more "kindred souls" in Technet then they did in their home departments. This creates a strong motivation for building a virtual community that can create virtual presence amongst these kindred souls. This requirement is important in organizations like

Technet where opportunities for face-to-face interaction are limited, but where collaboration and community-building are highly valued.

1.3 Community-Building Tools and Techniques

A VC is a community which brings people together, whether from a physical or pure computer mediated community. The previous two sections listed some factors that needed to be considered in order to build a successful VC. From the few VCs that were reviewed, the researchers found that social interactions need to be facilitated in such environments. VCs facilitate and augment face to face interactions (Poltrack & Engelbeck, 1997), therefore they should be supplemented with face to face interactions. People establish communication, collaboration, and coordination with each other through face to face interactions. Enhancing these three capabilities is a technique for community-building.

VC members communicate with each other using the components available in the community. Most VCs have a central meeting place accessible through the Internet. This central workspace is where all of a project's communications and documents reside (Alwang, 1998). Members can get updates on the group's mission statement, check important deadlines and instructions, initiate or join a discussion or real-time conference, and post documents. The tools for these VCs have to contain threaded discussion features, private email boxes, group email management, calendering and scheduling, voting utilities, chat spaces, customizable interfaces, newsgroups, document management, and real-time conferencing (Alwang, 1998; Boetcher, 1999; Marathe, 1999). Since the focus of this work is with research work groups, some Internet based methods that members can access and approach each other are: some form of notice boards on a website, group-based email for discussion or information sharing, and shared media archives for asynchronous access to project materials by group members.

Effective communication among community members is a key element to success for working collaboratively over the VC. Collaboration requires a higher order of involvement as well as a different approach to sharing and creating information. "Collaboration creates a shared meaning about a process, a product, or an event" (Schrage, 1990). In virtual communities, group members communicate what they think and want to do, then they collaborate by solving the created problem or discovering something within the group's expertise, time, money, competition and conventional wisdom. Virtual space supplements, rather than replaces other more traditional means of group communication (Toomey *et al*, 1998; Harasim, 1993; Walls, 1993). If the

communication in the virtual environment is not transparent enough, and its members revert to the more traditional means of group collaboration, the VC can be labeled unsuccessful. Working collaboratively over networks is ultimately about facilitating real communication (McGrath, 1998), enhanced by a virtual presence. Virtual environments facilitate a variety of communication strategies for VC participants.

Coordination among group members is required to properly make progress on projects when more than one person is involved. People often coordinate by updating status in scheduled meetings, where project members receive information, get task assignments, and review progress (Poltrock & Engelbeck, 1997). Group members do not discuss actual design problems or work in these meetings, but rather identify action items and appoint certain members to follow up on those items after the meting. Some activities that VC must support for coordination are work-centered (e.g. presenting, and reviewing products), people-centered (social activities) and meeting-centered (conference management for the virtual meeting) (Poltrock & Engelbeck, 1997).

Communication and collaboration within a virtual world is an example of a socio-technical system (schraefel *et al*, 2000). There are explicit and implicit policy and cultural barriers that emerge as one considers the issues of individual/group interaction in a constrained environment. Human coordination and policy-setting are as important as the technologies and tools that are used in the VC. schraefel *et al.* (2000) stated that individual researchers should initially create and project a 'sense of self' with respect to a VC. A context for collaboration is built for each relationship, using tools which suit the individual, the other members of the VC, and the task. They also proposed that members should be able to monitor, control and audit their contributions in the community, as well as to position and evolve each 'self'. Policies for how communication is handled among group members are particularly important when there is a range of media that can be used for different communication tasks. Agreements should be made among the group as to which is the appropriate way to deal with various forms of media (e-mail, phone messages, voice mail, fax) available on the VC. There should be a preferred method of communication in the group to avoid confusion and delay. For example, should the group post messages through the group's website, or through email or other forms of media? Should group members post documents or attached files in email? The design must support collaboration at any time, place, or level. The interactions in the virtual environment can be a cascade of events. For example,

casual personal interaction can turn into informal collaborations, which may then turn into formal meetings and/or continuous work plans. There needs to be a good understanding of network technology and how attributes in the technology affect users (Brinck, 1998).

Researchers at BT Laboratories (Sidhu & Bowman, 1999) recommended four key steps for supporting communication within a collaborative virtual environment. The VC must support group members in their decision to communicate. Secondly, group members can choose among a range of communication 'types' to perform this task. The VC must provide the necessary tools within the virtual environment to initiate communication as if users are in the real world. Finally, the VC has to support user requirements such as use of gestures during communication within the virtual environment.

Johansen defined a 2 by 2 matrix that differentiates groupware technologies in terms of their abilities to bridge time and space (Baecker *et al*, 1997, Kimball, 1997) (See Table 1). Interactions happen either at the same time (synchronous) or in different time (asynchronous). Geographical distribution can be local (same place) or distributed (different place).

	Same place (co-located)	Different place (distributed)
Same time (synchronous)	Face-to-face meetings: e.g. public computer displays, electronic meeting rooms, group decision support systems	Remote Interaction: e.g. Audio (telephone) conferencing, Video conferencing, media space
Different time (asynchronous)	Ongoing tasks: e.g. team rooms, group displays, project management	Communication and coordination: e.g. Voice mail, Electronic mail, Computer conferencing, Groupware (Intranets)

Table 1: Array of communication technologies (modified from Kimball, 1997).

For VC researchers distributed in various locations, the common scenarios are cases with different place-same time and different place-different time. Tools such as email, audio conferencing, video conferencing, decision support systems, web conferencing, and document sharing, are relevant in this context. Each type of media will achieve a different effect; choosing the appropriate medium among the technologies will be based on the group's goals and its flexibility in using the VC tools. Different media have different issues to consider. Kimball (1998) remarked that for electronic mail, norms such as email style, response time and method of delivery need to be established. Group members are required to develop relationships and

affective qualities, such as trust, for document sharing. Group members have a choice to contribute anonymously in decision-making support systems. Participants have to know the presence of others for audio conferencing. For video conferencing, it is necessary to make use of the video channel effectively to fully extend the attention span of participants. For asynchronous web-conferencing, relevant issues include allowing group members to participate at different times, and providing an overview or visualization of group activity.

Marathe (1999) suggested certain characteristics for building successful online communities. First, members of the VC have the option of generating content for the site and are able to determine its evolution. The VC can build its own personality with a clear context, thus allowing for self-perpetuation. Second, visitors to the community should be able to sense the presence of other visitors or members, and be aware of events occurring in the VC. Visitors should be welcomed to join discussions and interact with other visitors or members in the community. Impressions made in visiting the VC may attract new users to the site and motivate them to return. Third, members should find more value provided in the VC as it expands. Finally, innovative and integrated tools that can fuse commerce, content and community are necessary to establish bonds with other members of the VC. With these characteristics, the VC will be less centralized. Users and research groups can build and populate their structures. The VC is therefore free to grow and evolve based on the actions and interests of the various members of that community.

2 STICKINESS IN VIRTUAL COMMUNITIES

The previous section provided a summary of VCs and the tools and techniques that help to build them. The VC reviewed in this thesis already had an existing community, e.g., online classes and established research groups to work with. The improvement through the tools and techniques provided more interaction. On the other hand, for VCs which do not have an initial community, motivating users to use and to return to the VC may be difficult. Stickiness is yet another strategy to consider when constructing successful VCs. The following section will give an overview of stickiness in virtual communities.

'Stickiness' is a term that refers to the ability of a website to retain Internet users by providing contents that are interesting, useful and informative to net surfers (NetPlus, 1999; TechTarget, 1999). Similarly, a 'sticky' VC is one which net surfers want to visit frequently and regularly to discover it in depth. Not only do sticky VCs provide materials which attract visitors, these VCs

allow visitors to build a strong community identity. Stickiness is often measured in terms of the average number of hours that a user spends on a site in a given month (NetPlus, 1999). A good website measures stickiness in minutes and a good virtual community measures stickiness in hours (Morgan, 1999). Measurement of stickiness requires tracking the usage patterns of individual users, for example through member registration and login or cookies placed on the user's machine.

The focus of websites and VCs has shifted from aesthetically pleasing brochure design to true functionality and content. The Working Group from the first joint European Commission/National Science Foundation Advanced Research Workshop proposed that the "content age is the key driver for 2010" (Bruner, 1999). Website designers are shifting because they are looking for stickiness, since the best Web customer is a sticky customer: a consumer who has developed an affection, affinity or addiction to a site that compels him or her to return often (van den Berg, 1999). Companies such as America Online Inc., GeoCities and Yahoo! Inc. have mastered this concept and created portals for their own audience. Average stay for each session on these portal websites is about 30 minutes (Guglielmo, 1998). On the other hand, a not-so-sticky site might have the average user spending under 5 minutes each month (NetPlus, 1999). Online communities such as the Palace and Agora had a maximum use of approximately two weeks (Long, 1999). Users generally dropped out of the communities after two weeks.

Researches (TechTarget, 1999; van den Berg, 1999) done by companies wanting to increase consumer participation suggested several approaches to stickiness:

- To allow users to personalize
- Building discussion groups or a public forum
- Provide a feedback mechanism for users to voice their comments
- Use hypertext cross-references to other parts of the VC
- Have content in the site which adds value or expresses ideas/opinions in a new or different way than raw information otherwise available on the Internet

3 EVALUATION OF VC

After describing the building blocks of a virtual community and the approach to create a sticky VC, it is necessary to establish a method for evaluating VCs. A collaborative virtual environment, as defined in this context, consists of a set of web pages accessed through the Internet. Web

pages are made up of hyperlinks, in which users navigate by choosing the appropriate link. With the addition of multimedia on the Internet, the web pages now consist of hypermedia links: hyperlinks integrated with multimedia. Multimedia applications should always be subjected to some form of usability testing (Chignell & Waterworth, 1997). However, traditional usability evaluation originated from single user applications and does not necessarily address issues in collaborative tasks. Web site development is not solely the development of a single 'page'; it is the close interaction of content, navigation, and appearance of the website. Separate evaluation of any part of the web site alone is not enough (Scholtz & Downey, 1998). Moreover, a collaborative virtual environment is not only a single website; it represents a sense of community where creating a sense of presence and ability for members to collaborate are the main goals. Collaboration requires a good understanding of groups and how people function within groups (Brinck, 1998). VCs are used by researchers dispersed geographically over the Internet. Thus, several uncontrollable factors, such as Internet connection speed, may affect the performance. Steed & Tromp (1998) described evaluation of online network community as "a balance between the concerns of usability engineering and scientific enquiry frameworks". Evaluation of a virtual community is therefore an agglomeration of usability inspection for hypermedia applications and dimensions of networked community.

3.1 Methods of evaluation

The following section will identify some popular evaluation methods that can be used to assess a VC's components and attributes. Methods of interest are usability inspection, cognitive walk-throughs, hypermedia design model and mental workload analysis.

3.1.1 Usability inspection

Nielsen's heuristic evaluation is an information evaluation method designed not only for designs aimed towards complete novice users but for situations where the method of operation is not fully predictable. Heuristic evaluation involves usability inspection, where an inspection is used to list problems that can affect usability (Newman & Lamming, 1995). A team of evaluators inspects the interface's flow and content against the set of heuristics. The team of evaluators then aggregates the issues found on the interface to form a complete list. The ten design heuristics recommended by Nielsen and Molich (1990) and Nielsen (1992, 1993) are a set of general purpose user interface guidelines. They are summarized as follows:

1. Visibility of system status: The system should keep users informed through appropriate feedback within reasonable time
2. Match between system and the real world: The system should use familiar concepts, and real world convention to communicate with users
3. User control and freedom: Users are able to leave undesired state easily
4. Consistency and standards: The system should use consistent language and follow platform standards
5. Error prevention: Careful design should prevent an error from occurring in the first place
6. Recognition vs. recall: The user should not have to remember commands to get from one dialogue to another; the system should instruct or provide addition information
7. Flexibility and efficiency of use: The system should be flexible for both novice and experienced users, where users can tailor frequent actions
8. Aesthetic and minimalist design: Irrelevant information should be deleted
9. Help users recognize, diagnose, and recover from errors: Error messages should use precise language to report the problem
10. Help and documentation: The system should provide help and documentation and this information should be readily available to users

This simple analysis method has its advantages since heuristics evaluation is low cost in comparison to other formal usability inspection methods. The analysis is simple to perform, because no advanced planning is required and the team of evaluators can do the analysis separately (Nielsen, 1992). However, Nielsen and Molich (1990) also note that this heuristic evaluation focuses on problems rather than solution. The analysis suggests to fix errors on the proposed design rather than to recreate a new design. Moreover, heuristic evaluation is not as repeatable as other methods (Newman & Lamming, 1995) since each evaluator develops a separate list of problems from the analysis.

3.1.2 Cognitive walkthrough

Cognitive walkthrough is a method of analysis in terms of exploratory learning (Newman & Lamming, 1995). In the context of this thesis, Internet users visit the VCs without prior learning of how the VC functions. In these situations, the users have to learn how to use the system by exploring its interface. Cognitive walkthrough measures how users explore and learn how to use the interface and therefore is concerned with success rate and recovery from error, instead of task performance (Newman & Lamming, 1995).

The evaluators explore the interface by achieving a predefined task. From this process, they discover problems concerning:

1. Is the interface sufficient to tell the users what to do?
2. Is the mapping between user's action and action description correct?
3. Will the system's response to user's actions be interpreted correctly by the user?

3.1.3 Hypermedia model

Garzotto, Paolini, & Schwabe (1993) developed a hypermedia model named HDM (Hypertext Design Model) to describe hypertext application which can be used as a modelling device or an implementation device. The model has the concept of perspective, which is to have different presentations for the same content. Links are also categorized as structural (links to move up or down the tree structure), application (links causing the context of pages to change abruptly), and perspective (links to different presentation of the same content).

Further work by Garzotto and Matera (1997) on the HDM led to a usability evaluation methodology named SUE (Systematic Usability Evaluation). This model uses a number of usability attributes in which a hypermedia application will be analyzed. The dimensions are structure, navigation, behaviour, user control, and presentation (Garzotto and Matera, 1997). Structure describes the content's organization; navigation studies the links of the website; behaviour checks the functions and links of the website; user control concerns the available interaction components; and presentation deals with features shown to users, e.g. layout and visual appeal. In addition, SUE considered learnability and efficiency within the usability attributes. Learnability defines how well the hypermedia feature helps novice users gain increasing mastery of the system. Efficiency is the ability of the hypermedia feature to enable users to reach their goals.

3.1.4 Mental workload analysis

Although performing collaborative tasks through VC is not a concern for time-sharing events, the mental workload imposed on the users reflects usability issues. Potential users of a VC may not like to re-visit the VC when it requires considerable amount of mental effort to manipulate the tools and interfaces. The potential members may prefer to use a VC which can efficiently help them communicate and collaborate with each other using simple and transparent tools and interfaces.

The mental workload analysis points out the demand a task imposes on a user's limited resources (Wickens, 1992). Hart and Staveland (1988) proposed factors that are associated with variations in subjective workload. These factors are defined in the NASA-TLX rating scale:

1. Mental demand
2. Physical demand
3. Temporal demand
4. Performance
5. Effort
6. Frustration level

Mental demand is the perceived mental activity required. Physical demand is the amount of physical activity to complete a task. Temporal demand is the time pressure created while completing tasks. Performance is the satisfaction of users with their goals and performance. Effort is the perceived mental and physical demand used to achieve a certain preset level of performance. Frustration level is the amount of annoyance or dissatisfaction of the user in completing tasks. Since the tasks in the VC evaluation were not physical (except from controlling input devices) nor time demanding (because evaluators can complete tasks at their own pace), the physical demand and temporal demand ratings seem inappropriate in this context.

3.2 Review of evaluation methodologies in use

VC evaluation cannot be performed using a single usability testing technique, but requires some combination of the evaluation methods described above. Researchers have attempted to develop combination of usability evaluation techniques that could be applied to groupware (e.g. Steed & Tromp, 1998; Gutwin & Greenberg, 2000). The following section reviewed some examples of the works that had been done in improving the techniques for evaluating VCs.

Schiano and White's (1998) research on LambdaMOO attempted to incorporate subjective and objective methodologies to characterize people's life in online communities by performing three primary studies: online survey, personal interviews and logging study. The online survey addressed four categories of interest where participants filled in a "survey room" in LambdaMOO. Local residents were interviewed about their experiences, views and issues on using LambdaMOO in an unstructured and conservational manner. The status on the virtual

character and room objects for LambdaMOO was logged to record the characteristics of the participants' path and time while using the online community.

Steed and Tromp's (1998) work on their collaborative virtual environment (COVEN) project included usability evaluations on their two prototypes. Their work proposed a framework for evaluating collaborative virtual environments. The framework included the traditional usability engineering approach such as heuristic evaluation and cognitive walkthrough methods along with scenarios that cover the collaborative aspects of the virtual environment. Their second study was to determine how participants used various communication media to collaborate through a series of web-based questionnaires. They discovered that the questionnaires covered the use and efficiency of the collaboration services, whereas the heuristic evaluation covered the application component.

Gutwin and Greenberg (2000) introduced a conceptual framework for evaluating shared workspaces from existing evaluative techniques. They assumed the groupware system was usable from a single-user perspective and the only inspection required was for aspects of group interaction. The mechanics of collaboration they defined examined the effectiveness, efficiency and satisfaction of participants when using the groupware. Discount evaluation methods such as heuristic evaluation, walkthroughs, observations and user questionnaires were used to build up the framework for evaluating usability problems in groupware systems.

Schuler (1996) quoted a 1995 written report on the evaluation of community networks by Kathleen Gygi from University of New Mexico. Gygi described two main types of evaluation. One was to perform a comparative analysis of the computer-network systems in which individual systems (or generic computer-network models) were compared. The second type was to assess the individual community-network system according to the goals or criteria that the organization or community designated as important. For the comparative analysis, Gygi suggested five dimensions (services, capacity, accessibility, ownership, and financing) for comparing community-network systems and models. These dimensions were used to establish the network's initial goals and design approaches.

These were some techniques that researchers used to evaluate community networks. Some of these works were concepts and some were derived from researchers' experiences when evaluating

their own community networks. A modified evaluation methodology was used in this thesis based on a combination of the traditional inspection methods described in the previous section. The methodology will be further described in Chapter 3.

4 PERSONALIZATION

Personalization is viewed as a method to increase participation in VCs (van den Berg, 1999). People want a system that they can control more easily and one which fits their own needs. The study of personalizing the interface for users is necessary to present an interface that is easy, efficient, and effective to use. All the building blocks of the VC could be tailored to its users; however, it is not clear which components need to be personalized and how personalization should happen. Evaluation methods described in the previous section determine if the VC had met the needs and requirements of users. The results from these evaluations identify which components required personalization. In a VC, the experience and skills of the participants may vary. Advanced computer users may be uncomfortable using interfaces designed for novice computer users, and vice versa. An effective VC has the ability to identify its target users and be familiar with the activities for different situations. Usability is concerned with achieving harmony between the user, task, system and environment (Benyon, 1993).

Jakob Nielsen distinguished between the two terms: personalization and customization. He defined customization as an act "under direct user control [which] the user explicitly selects between certain options", e.g. preference settings (Nielsen, 1999). On the other hand, personalization "is driven by the computer which tries to serve up individualized pages to the users based on some form of [user] model", e.g. agents (Nielsen, 1999). The following section will provide an introduction to personalization and some simple techniques for personalizing.

4.1 Personalizing For The User

Information about the individual user must be considered when personalizing for the individual. A good personalization system uses its knowledge about the user to make the user comfortable in using it. Factors used most commonly for system input are: characteristics, abilities, interests, behaviour, needs and preferences (Dieterich *et al*, 1993). Benyon (1993) also added other factors such as: factual knowledge that could be misunderstood; cognitive factors such as the user's level of spatial ability, preferred learning style or field dependency; and personal 'profile' characteristics such as previous experience, age, and gender. Brusilovsky (1996) defined five

different personalization factors from his hypermedia studies. The factors were: user's goals, knowledge, background and experience, hyperspace experience, and preferences.

Various researchers performed studies of adaptive user interfaces as an attempt to overcome increased complexity of user interfaces. Adaptivity is a means to accommodate users with different needs, background knowledge, interaction style, and cognitive characteristics, using techniques such as artificial intelligence. Adaptive user interfaces consider both the individual needs of users, and changing conditions within an application environment.

Adaptive systems are useful when users cannot or prefer not to accommodate to the system. An efficient adaptive system requires only those features which give the largest impact on the interaction between the users and system, and adapt to the needs of intermittent and discretionary users (Benyon & Murray, 1993). Common adaptive systems provide an adaptive interface, help, navigation support, functionality, content, or filtering.

Adaptive interfaces change the interface to suit users. Their use is by far the most common method of personalization. Adaptation can occur through choosing a diversity of presentation forms of content, or through changing the layout configuration of the system interface according to user characteristics and expertise (Brusilovsky & Schwarz, 1997; Dieterich *et al*, 1993; Gukauf, Thies & Domik, 1997). Adaptive help systems provide user support through different representation of help. The help can be designed to match the experience level and media preferences of users. Adaptive navigation support techniques can significantly decrease user search and navigation efforts, thus decreasing the time required to complete a task (Brusilovsky, 1997). Adaptive hyperlink systems assist users in finding their paths in hyperspace by presenting links according to their goals, topic of interest, context for that situation, knowledge, and other personality characteristics of the users (Brusilovsky, 1997; Brusilovsky, 1996; Simons, 1997; Stefani & Strapparava, 1998). Adaptation of functionality adapts to the users' working style, generating macros, hot keys, and other function keys that the users use frequently. Tasks are dynamically allocated to either the system or the function, depending on the stress or needs of the users. The system adjusts the content of the page according to the particular user's current knowledge, goals, and other characteristics (Brusilovsky, 1997; Brusilovsky, 1996; Brusilovsky & Schwarz, 1997; Not & Zancanaro, 1998). Similarly, incremental interfaces disable features and contents, or introduce those features incrementally with hints. The adaptive system removes

or filters undesirable documents for users performing Internet search. The system uses the information obtain through the web browser to filter more documents according to the documents read by the user, clicking behaviour, and the user group to estimate user's browsing strategy or reading capacity (Simons, 1997).

Dieterich *et al.* (1993) summarized several other researchers' work to produce a list of the necessary information that must be considered when designing adaptive systems. The list divided into three main categories: user, application, and design constraints. The systems need to separate the difference between a typical user, user groups, and individual users where each type has unique needs, preferences, user characteristics, abilities, interests, behaviour, personal knowledge and experience.

4.2 Methods and techniques of personalization

One simple way to perform personalization or customization is to let users set preferences and system behaviors themselves. This type of system does not require much intelligence. The system receives the input from the users, computes the values and makes the appropriate adjustments. There are several customization techniques: e.g. preferences, templates, customizable work spaces, and end-user programming via script (Baecker *et al*, 1995; Long, 1999). Building customizable features in the system to handle users' needs is a simple and efficient method, however there is also an interface component required for choosing the options.

Customizable tools and tool integration are significant ingredients for an environment's success. With the variety of communication media available for research VCs, should the VC provide a default set of tools or to allow for successful integration of tools with which a user may already be comfortable? If the user finds the VC version of a tool too constraining (e.g., files can only be submitted via using the VC's method, excluding other forms of FTP access), then the user may simply avoid uploading material to the community (schraefel *et al.*, 2000).

An "intelligent" interface is a system which is more active and takes the initiative to adapt its interface or its interaction model to fit the perceived needs of its users (Baecker *et al.*, 1995). The users delegate a range of tasks to the system to act on their behalf. The adaptation process normally consists of: enabling the system to collect data about the user either directly or indirectly; processing the data to build or update the user model; applying the user model to decide upon the changes; executing the adaptation. Designers for adaptive systems should make

sure the user never feel out of control, disturbed, or misled (Encarnacao, 1997). The intelligent VC keeps track of the member's usual behaviour, e.g. their most visited place, the most used tool, the usual contact list. With this learned information, the VC can intelligently assist the members in performing tasks in the VC.

5 CONCLUSIONS

This literature review has provided an overview of virtual communities and how they help researchers to work together when they are not located in the same physical space. This chapter reviewed the traditional methods of usability evaluation, such as heuristic evaluation and cognitive walk-through. It observed that there are insufficient methodologies for evaluating virtual communities; there are many challenges in understanding, designing, and evaluating them. There are not enough non-task based virtual communities, and the stickiness for those studied was not high. Not only is it necessary to provide good usability for a virtual community, there is a need to devise a way to attract and make members continue using a virtual community for collaboration purposes. Methods such as personalizing or customizing a virtual community for a group or individuals were recommended. There is a potential for a usability-based approach to evaluation of virtual communities. Such evaluation requires an understanding of the properties of virtual communities and appropriate design for those so as to improve stickiness. The following chapter will introduce a methodology for such evaluation and will prove a case study that evaluates a VC.

CHAPTER 3

METHODOLOGY AND SAMPLE

CHAPTER 3: METHODOLOGY AND SAMPLE

After identifying components that could potentially be integrated into virtual communities, and the pool of evaluation methods for inspecting them, this thesis will explore a methodology by carrying out an evaluation on a virtual community. Since most researchers developed their evaluation framework through continuous user studies and monitoring the progress of their VCs, a similar approach will be used in this thesis to develop an improved methodology for evaluating and building VCs. The Bell University Labs website was chosen as the VC to be evaluated because it was at its initial stage of development during this thesis research. The goal of this VC is to create a flexible virtual workspace through the use of different tools designed for collaboration. Evaluation in this environment could identify the tools most useful to support research collaboration at a distance. This chapter provides a brief history of Bell University Labs and its website. The evaluation methodology used to evaluate the Bell University Labs website will be discussed. Finally, the background information of the user study's participants will be described.

1 BELL UNIVERSITY LABS (BUL)

The Bell University Labs (BUL) is a research and commercial network bringing together Bell Canada and the Universities of Toronto, Waterloo, and Quebec Learning Institutions, to collaborate in the development of shared intellectual capital. The Bell University Labs website was designed to function as a virtual campus. This virtual campus created an institutional environment where participants interacted with each other in the website's conference and research centers. The participants posted documents, appointments, deliverables, and more on the website. The works posted on the website were under the explicit control of the originator in order to protect and properly recognize the contribution of each participant.

The BUL website had five general areas: *Labs*, *Pubs*, *Commons*, *Conference Center*, and *Library*. The *Labs* was a secure area where participants discussed work in progress in private groups, thus allowing collaboration and technology transfer between the commercial and academic settings in focused teams. The content was secured until the work was published in the *Library* or elsewhere by the author(s). The *conference centre* was the area to invite a broader audience or the general public to participate in work discussions. The *Pub* was a free form-discussion area of the site that

was completely open to new topics and many forms of discussions. The *Commons* was a public event announcement area.

Access was a key issue to consider so that researchers were able to access the information even when in places not on the company's intranet network system. Moreover, they were more comfortable in allowing third party access to this virtual campus than to the company's intranet. Thus the virtual campus provided necessary protection for the researchers.

2 EVALUATION METHODOLOGY

Summarizing the evaluation methods described in chapter 2, the first step of heuristic evaluation provided quick feedback of the website's performance and participants' preferences by an expert user. Other forms of the evaluation methods were carried forward in the form of a questionnaire and personal interviews. The questionnaire is an instrument used to study a research problem with a collection of questions and statements given to a sample of individuals (Mantei & Marshall, 1998), and is used for gathering enough data to perform statistical analysis (Newman & Lamming, 1995). The questionnaire asked for participants' preferences on structure, navigation, behaviour, user control, presentation and functionality of the BUL website. Personal interviews with actual participants of the VC were used to study their personal experiences from using the BUL site. As Newman and Lemming (1995) mentioned that interviews are a quick and common way to perform an analysis where results are available immediately. The last method used was the web server log study. The web server log contained data necessary to track the usage of the VC.

2.1 Questionnaire

A questionnaire was handed out to a number of participants who were currently using the VC for their research projects. Users of the VC could freely accept or decline to fill out the questionnaire. There were a total of 33 questions to identify the participants' satisfaction of the VC. The questions were based on Nielsen's ten heuristic for the web (Nielsen & Molich, 1990), Garzotto and Matera's SUE methodology (Garzotto & Matera, 1997), and NASA-TLX rating scale (Hart & Staveland, 1988). The questionnaire was divided into six categories:

(1) structure of the content's organization
(2) navigation of links used to explore the website's structure
(3) behaviour of functions and links of the website
(4) user control of available interaction components

(5) presentation of features shown to users, e.g. layout and visual appeal, and
(6) functionality of the component and workload analysis

The questionnaire is attached in Appendix A. Participants were asked to indicate their agreements with the statements presented in the questionnaire on a 5-point Likert scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). In the last section of the questionnaire, participants were asked to provide ratings, again on a 5-point Likert scale (Low, Below Average, Average, Above Average, High) for the statements.

2.1.1 Cluster analysis

Cluster analysis was used to analyze the questionnaire data. The cluster analyses used in this thesis were carried out using the clustering methods available in SPSS for Windows version 10. Cluster analysis classifies a set of observations into two or more groups based on the nature of the variables (see Everitt, 1993 for a discussion of the available techniques). The purpose of cluster analysis is to organize the observations which share similar properties into groupings where the observations within each group are similar to each other, but different from observations in other groups. The similarity of group members can then be used to predict the behaviour or properties of people based on which group or cluster they belong to. The aim in cluster analysis is to create groups which minimize the variation between individual members in each cluster while maximizing the difference between groups. There are a number of algorithms for combining the groups; different algorithms may result in a different grouping structure for a given set of data. Hierarchical clustering with agglomeration was used as one technique (Ward's method), while K-means partitioning was used as the other method in the data analysis for this study. Both of these widely used clustering methods are generally reported to give good results.

Hierarchical clusters are organized so that one cluster may be entirely contained within another, but no other kind of overlap between clusters is allowed. As more and more objects are grouped together and amalgamated into larger and larger clusters of dissimilar elements, the result data should be structured into branches of similar clusters. The agglomerative techniques start to place each object into a subgroup and then combine like subgroups together until only one group remains. (Statsoft, 2000)

When forming the clusters, there are several ways to calculate the distances between objects. The distance measures can be based on single or multiple dimensions. Some common measurements

are: Euclidean (geometric distance in multidimensional space), city-block (average distance across dimensions), Chebychev (difference in any one of the dimensions), or power distance (parameters for the weighting for progressive weightings) between the objects. Ward's method uses an analysis of variance approach to evaluate the distances between clusters (Everitt, 1993). The method tries to minimize the sum of squares of any two clusters that can be formed at each step. Even though this method is considered very efficient, it tends to create small-sized clusters of roughly the same number of observations.

Another method for clustering which differs from hierarchical clustering is k-means clustering. There is no hierarchy; the number of clusters supplied partitions the data. Cluster variability is measured with respect to their means for the classifying variables (See Anderberg, 1973 for a more detail discussion). The objective is to minimize variability within clusters and maximize variability between clusters (Statsoft, 2000).

2.2 Personal interviews

In addition to questionnaires for the inspection of the BUL website, personal interviews with VC members were used to further explore the issues in the VC. On top of the system and usability issues, participants were asked for their experience in using this VC and its effectiveness for the network community. Individual participants of the VC were interviewed in a location where they could discuss their experience while using the VC and express their views on issues. Each session lasted about 30 minutes.

2.3 Server log study

The logs of the web server were recorded and analyzed. Logging data for 6 months were used in the study, from September 1999 to March 2000. The web log data were recorded through Microsoft Information Server 4.0 from the web server for the virtual community. The data were logged whenever there was a transaction in the server. The data contained time for each transaction with the server, the script called or page visited, and the status of the server. A perl script was written to parse the data for analysis. The login and logout times were calculated for the login duration. The usage of each feature was tabulated and timed when there was a record of the particular webpage or code called from the server.

3 SUBJECT BACKGROUND

3.1 Choice of subjects

Since the intended audience for the Bell University Labs website were groups who were not working in the same location or time, the participants chosen for this study were working in groups in which face to face communication was difficult to manage. 15 participants of the VC filled out the questionnaire. All participants were unpaid volunteers. 12 participants used the VC for schoolwork while the other 3 participants used it for work. The twelve students used the BUL website as a tool to support projects within a graduate class on mobile computing. The students were encouraged to use the website to support their projects, but participation was optional. Out of the eight groups in the graduate course, three groups chose to use the BUL website actively during the evaluation period. The other five groups either were not interested in participating or they converted back to more traditional communication methods.

The three industry partner participants worked on projects which involved collaboration with separate companies. They learnt about the VC in management meetings and were interested in trying the VC for this type of inter-company collaborative work. It was not convenience for them to email large files to all members of the group. Moreover, they need a central file storage space where the collaboration parties could obtain the latest documents at a common repository.

All the participants were given a brief overview of the purpose and functionality of the BUL website. All of them had used the Internet for over 3 years (s.d. 0.49) (Figure 1), and typically used the Internet more than once a day.

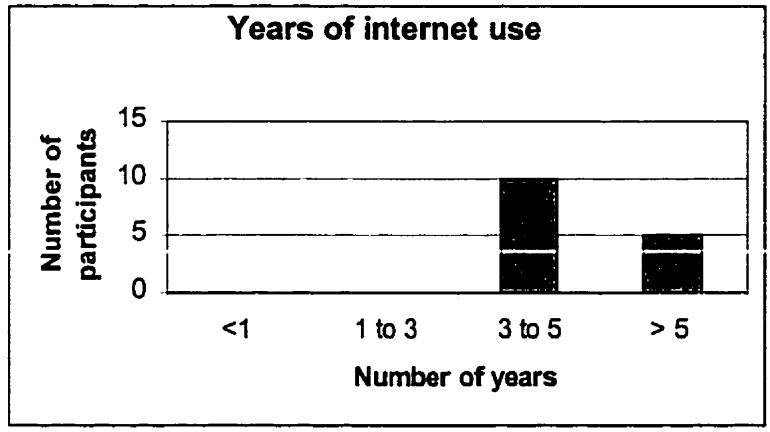

Figure 1: Questionnaire user profile: Years of Internet use

There were more variations in the amount of experience in using Internet chat software, newsgroups or other discussion sites (Figure 2), with 40% (s.d. 1.05) of respondents having one to three years of experience.

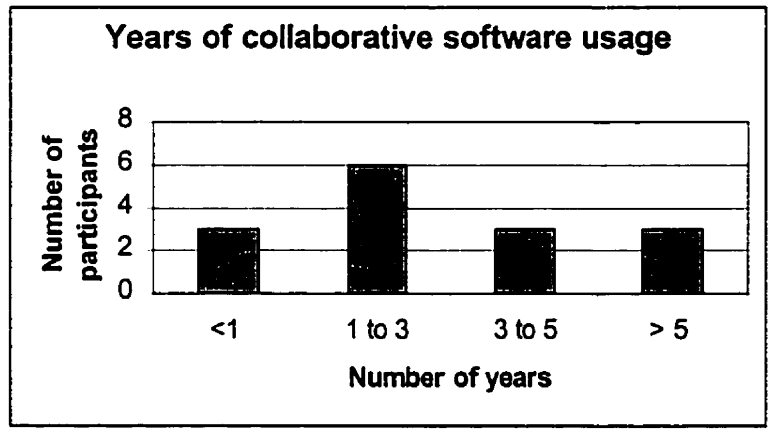

Figure 2: Questionnaire user profile: Years of collaborative software usage

47% of the participants (s.d 1.96) used the Internet collaborative software (e.g., chat, newsgroups or other discussion activity on the Internet) more than once daily (Figure 3).

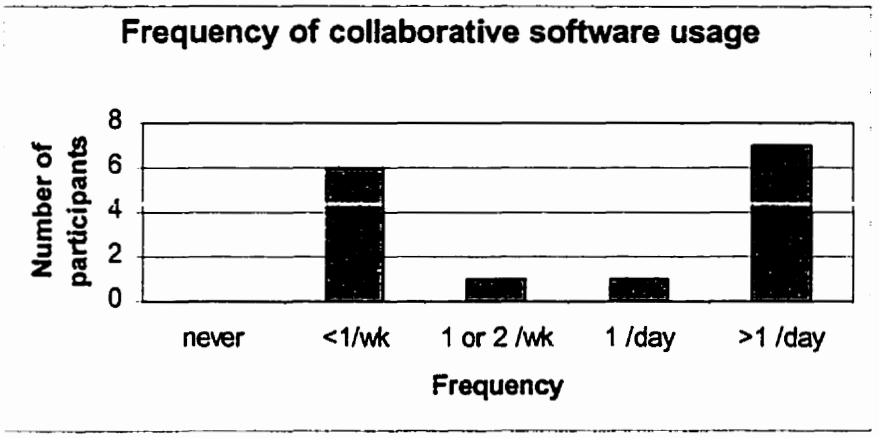

Figure 3: Questionnaire user profile: Frequency of collaborative software usage

Five virtual community members participated in the interview session. Their level of experience ranged from low to very experienced in Internet collaboration software. The interviewed participants used the VC for project collaboration at the time of the interview; they had their team set up first, and then joined the VC; therefore they were all acquainted as classmates or co-workers.

CHAPTER 4

USABILITY ANALYSIS OF BELL UNIVERSITY LABS WEBSITE

CHAPTER 4: USABILITY ANALYSIS OF BUL WEBSITE

As explained in the previous chapter, an empirical study was undertaken of the BUL website users. This study was performed in order to determine if the BUL website was easy to use and met users' expectations, and to explore a methodology to help build a successful virtual community. This chapter will present the results of that study.

1 QUESTIONNAIRE RESULTS

1.1 Descriptive statistics

The results were first analysed descriptively. (A summary of the questionnaire is provided in Appendix B.) For most statements in the structure section, most of the responses were close to the center of the Likert scale (with means from 3.27 to 3.53). By contrast, participants generally agreed with statement 4 ("The maps or overviews help me to locate where I am within the website"), with a mean of 4.0.

For questions in the navigation section, again, most responses were neutral, with means from 3.13 to 3.47 on the Likert scale, with the exception of statement 2 ("I can logout of the website quickly") which had a mean of 3.60, indicating that the participants slightly agreed with this statement.

The responses in the behaviour section tended to be slightly positive (with means ranging from 3.60 to 3.87). The two statements in the user control section had means of only 2.73 and 2.93 respectively; the participants disagreed with the statement that "The website supports undo and redo functionality" and "I can cancel my previous action and proceed to another page".

Responses in the presentation section tended to be neutral, ranging from a mean of 3.13 to a mean of 3.67. Exceptions to this pattern were found in statements 3 and 6, where a mean of 2.87 (slightly disagreeing) for "There were irrelevant and extraneous materials on the website that I found distracting", and a mean of 2.67 (slightly disagreeing) for the statement "The help function provided is useful", respectively. The response for the last question was interesting, because while there was a "help" button, there was no help information actually available if the help button was pressed. Item 9 had the lowest level of agreement in the questionnaire, with a mean of only 2.4, for the statement "In the event of an error, there are helpful solutions to solve the issue".

Finally, for the functionality section, responses were neutral. The participants were also asked to provide ratings of the perceived workload when using the VC. The responses were close to the neutral rating point, with a mean ranging from 2.93 to 3.53.

The participants were generally satisfied with the structure and organization of the VC. They stated that the structure and organization of the site were represented consistently and were easy to understand. The participants were also satisfied with the navigation tools available in the VC. They were able to go to the links to other pages via the provided links. However, they became disoriented at times and did not know where they were in the VC. Participants were satisfied with the VC's general behaviour; they understood the text used, and the functions presented were familiar to them. The participants were dissatisfied with the user control aspect of the VC: they were not able to make changes or to cancel their previous action. Most participants responded that the layout of the VC was appealing. They responded that the features were consistent and that the mappings of the buttons and functions were consistent. However, more help and information would be useful. Even though the participants were able to accomplish their goals using the VC, and did not have difficulty finding items, they had to put more than normal effort into looking and searching for relevant pages in order to achieve their goals. However, though the difficulty level in finishing tasks was average, the level of discouragement or annoyance was below average.

1.2 Cluster analysis

Cluster analysis was used to identify possible relationships among the participants. Three cluster analyses were performed: one with the whole questionnaire, one with only structure and navigation questions and the third one with only presentation and functionality questions. Since it was a large questionnaire, separate cluster analyses of subsections of the questionnaire were done in order to get more focussed groupings of the subjects. For the one analysis, questions on the grouping structure and navigation were used (a total of 13 questions). The presentation and functionality questions were used for a second cluster analysis (a total of 15 questions). Only these four sections of the questionnaire were selected, because some of their questions contributed to the cluster memberships (explained further in section 1.2.1), and these four sections contained the bulk of the items in the questionnaire. The structure and navigation questions were very similar and thus grouped together, leaving presentation and functionality questions for the other analysis.

1.2.1 Cluster analysis for the whole questionnaire

The first analysis carried out cluster analysis on all the items in the questionnaire. Using Ward's method, subjects were grouped into three main clusters (Table 2). The numbers corresponded to the subject ID numbers and were used in this case to signify cluster membership.

Cluster 1:	Cluster 2:	Cluster 3:
1, 5	2, 4, 6, 8, 11, 12	3, 7, 9, 10, 13, 14, 15

Table 2 : Cluster membership for subjects using Ward's method

A similar grouping was obtained using k-means cluster analysis with k=3 (Table 3). There were only three differences in the groupings obtained using the two methods: subject 3 was grouped with the first cluster (in k-means, but not Ward's clustering), and subjects 12 and 15 were swapped between two clusters for the two methods. The overall similarity between the two clustering methods increases confidence in the groupings obtained.

Cluster 1:	Cluster 2:	Cluster 3:
1, 3, 5	2, 4, 6, 8, 11, 15	7, 9, 10, 12, 13,14

Table 3 : Cluster membership for subjects using k-means method

For interpretative purposes, the k-means clustering solution was chosen for further analysis. ANOVA was used to identify which of the questionnaire items contributed to the questionnaire effect (with cluster membership being used as a pseudo-factor[1]).

Ten questionnaire items were significant in forming the clusters. One significant difference in the cluster members was the frequency of Internet collaboration software usage between participants ($F=6.015$, $p=0.016$[2]). Cluster 1 and 2 members used such software at least once per day, whereas cluster 3 members used the software less than once per week.

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[1] Since ANOVA used the cluster membership as a grouping variable, where group clusters had been formed by maximizing the differences in the same data, the F-test could only be used for descriptive purposes. The purpose of this ANOVA was to identify which questionnaire item was differentiating between the clusters.

[2] The P value obtained was not corrected for these maximized differences of cluster membership; therefore it should not be interpreted a test of the hypothesis that the cluster means were equal.

In the presentation section of the questionnaire, statement 2 ("The titles and headers are worded consistently throughout the website") was assigned a low probability value (F=6.083, p=0.015: cluster 1 members tended to disagree with the statement, while cluster 2 and 3 members tended to agree with the statement). Statement 3 ("There were irrelevant and extraneous materials on the website that I found distracting") also appeared to differ between cluster (F=4.302, p=0.039: cluster 1 members tended to agree with the statement, and clusters 2 and 3 members seemed to be neutral). The statement "The screen layout of the website is appealing" -- statement 4 -- (F=3.913, p=0.049) also was diagnostic. Clusters 1 and 3 members agreed with the statement, but cluster 2 members disagreed with the statement.

In the structure section of the questionnaire, statement 2 ("The organization of materials on the website is easy to understand") differed with F=34.8 and p=0.000: cluster 1 members disagreed with the statement, while clusters 2 and 3 members agreed with the statement. Statement 3 ("There are too many levels of nesting on the website") differed with F=7.815, p=0.007: cluster 1 members strongly agreed with the statement, and clusters 2 and 3 members were neutral for the statement. Statement 4 ("The maps or overviews help me to locate where I am within the website") differed with F=5.52 and p=0.020: cluster 1 members were neutral with the statement, and cluster 2 and 3 members agreed with the statement. Statement 5 ("I am able to visualize the whole structure and layering of the website") differed with F=22.235 and p=0.000: cluster 1 members disagreed with the statement, where clusters 2 and 3 members agreed with the statement. Statement 6 ("The organization of materials on the website is represented consistently") differed with F=15.120 and p=0.001: as in statement 5, cluster 1 members disagreed with the statement, where clusters 2 and 3 members agreed with the statement.

Finally, the three clusters tended to differ in navigation statement 3 -- "There are enough links to jump to relevant area in the website without going through too many links"-- (F=15.120, p=0.001). Cluster 1 members strongly disagreed with the statement, while clusters 2 and 3 members agreed with the statement.

Cluster 1: Negative responses

These users had 3-5 years Internet and collaboration software experience. They used Internet more than once a day and they used Internet collaboration software at least once a day. This group of users liked the screen layout (agreed to the statement for item 4 of the presentation

section: "The screen layout of the website is appealing"); however, they agreed that "there were irrelevant and extraneous materials on the website that I found distracting" (item 3 of presentation section) and disagreed with the statement that "the titles and headers are worded consistently" (item 2 of presentation section). The users believed that much work was required to complete any task on the VC (The ratings they provided for the amount of work spent on looking for relevant pages -- functionality item 4-- was high, and the difficulty and amount of effort used to perform tasks was above average --functionality items 1 and 2). This made it hard for users to achieve their ultimate goals. Subjects tended to disagree with the statement for functionality item 6: "I was able to perform tasks and accomplish my goals on the website efficiently". The subjects did not like the organization and nesting of materials on the VC. Subjects tended to disagree with the statement-- structure items 1, 2, 5, and 6: "It is easy for me to find desired items on the website", "The organization of materials on the website is easy to understand", "I am able to visualize the whole structure and layering of the website", "The organization of materials on the website is represented consistently", and strongly agreed with the statement -- structure question 3: "There are too many levels of nesting on the website". The navigation on the VC caused disorientation (subjects in this cluster tended to agree with the statement of navigation section item 5: "I got disoriented at times and wasn't sure where I was in the website"), also, there were not enough links to go to relevant areas in the VC (subjects in this cluster strongly disagreed with the statement of navigation section item 3: "There are enough links to jump to relevant area in the website"). Members of cluster 1 also disagreed with the statements about user control section 1 and 2: "The website supports undo and redo functionality" and "I can cancel my previous action and proceed to another page".

Cluster 2: Slightly positive group

The second group of users had more than 5 years of Internet experience and used the Internet more than once daily, but they only had 3-5 years of regular collaboration software experience. These users did not like the screen layout (subjects in this cluster tended to disagree with the statement from item 4 of the presentation section: "The screen layout of the website is appealing"), and they complained that there were no helpful solutions when an unknown error happened (subjects in cluster 2 tended to agree with the statement "There are unknown error without proper messaging" and tend to disagree with the statement "In the event of an error, there are helpful solutions to solve the issue"). Cluster 2 members stated that an average amount of work was required to finish a task (items 1, 2, and 4 of the functionality section), but they needed

above average effort to perform a task (item 1 of the functionality section). The organization and navigation assistance of the website made it easy to find items, and cluster 2 members were satisfied with it (e.g., subjects tended to agree with the statements items 1, 2 of the navigation section: "It is easy for me to find desired items on the website" and "The organization of materials on the website is easy to understand", as well as with most other questions in the structure and navigation sections).

Cluster 3: Less experienced but positive users

Cluster 3 members responded very similarly to cluster 2 members. The significant difference was in their collaboration software skills. These users were the weakest group of the three clusters in terms of Internet collaboration software skill; they only had 3-5 years of Internet experience and 1-3 years of regular collaboration software. This is the positive group, whose their responses were either 3 or 4 on the Likert scale. For example, they claimed that average workload was required to use the VC (items 1, 2, 4 of the functionality section), and responded positively to most aspects of the VC.

1.2.2 Cluster analysis for subsections of the questionnaire

Structure and Navigation (S/N) clustering:

Both Ward's and K-means methods for cluster analysis were performed for this section of the questionnaire. For the S/N section, the clusterings obtained were almost identical across the two clustering methods. Using Ward's method, three clusters were formed as shown in Table 4.

Cluster 1:	Cluster 2:	Cluster 3:
1, 3, 5	2, 4, 6, 7, 8, 9, 10, 12	11, 13, 14, 15

Table 4 : Cluster membership for subjects using Ward's method (S/N questions only)

For k-means, with k=3, the only difference was subject 13 being grouped in cluster 1 (Table 5).

Cluster 1:	Cluster 2:	Cluster 3:
1, 3, 5, 13	2, 4, 6, 7, 8, 9, 10, 12	11, 14, 15

Table 5 : Cluster membership for subjects using k-means method (S/N questions only)

Interpreting the k-means cluster analysis with the smaller number of question groupings, the clusters could be classified as having negative, positive, and neutral attitudes towards the structure and navigation aspects of the VC.

ANOVA of the cluster membership was again used to identify which questionnaire items contributed to the questionnaire effect. The three groups differed most in questions 1-6 of the structure section and questions 2 and 3 of the navigation section. The organization of materials, the level of nesting, and the maps/overview affected the ease of searching items on site and in visualizing the whole structure. The number of links available for participants to leave the VC quickly also affected preferences.

Cluster 1: Negative attitude for structure and navigation

Participants in this cluster did not like the structure and navigation of the VC. They disagreed that "the organization of materials on the website is easy to understand" (Structure item 2), and they strongly agreed "there are too many levels of nesting on the website" (Structure item 3). This caused them not to be able to "visualize the whole structure and layering of the website" (Structure item 5). These participants strongly disagreed with the statement that "there are enough links to jump to relevant area in the website" (Navigation item 3) and agreed they "got disoriented at times and wasn't sure where [they were] in the website" (navigation item 5).

Cluster 2: Positive attitude for structure and navigation

Participants in this cluster were pretty satisfied with the structure and navigation of the VC. They agreed to most of the positive statements in the sections, for example, items 1-2, 4-8 in the structure section, and items 1-3 in the navigation section.

Cluster 3: Neutral for structure and navigation

These participants tended to be neutral in how they felt about the structure and navigation aspects of the VC. They responded neutrally for most of the questions in these two sections.

Presentation and Functionality (P/F) clustering

In contrast to the earlier cluster analyses, cluster analysis on the presentation and functionality sections yielded different groupings across the two clustering methods used (Ward's method and k-means). Using Ward's method, three clusters were again formed (Table 6). On the other hand,

with k-means, with k=3, the cluster groupings were relatively similar to the k-means clusters formed for the S/N analysis (Table 7).

Cluster 1:	Cluster 2:	Cluster 3:
1, 2, 3, 9, 13, 14	4, 7, 8, 10, 12	5, 6, 11, 15

Table 6 : Cluster membership for subjects using Ward's method (P/F questions only)

Cluster 1:	Cluster 2:	Cluster 3:
1, 3, 5	2, 4, 7, 8, 9, 10, 12, 13, 14	6, 11, 15

Table 7 : Cluster membership for subjects using k-means method (P/ F questions only)

K-means analysis was thus more consistent in the groups of subjects obtained with different questions used for the cluster analyses. For example, subjects 1, 3, 5 and 2, 4, 8 were always grouped together for the three k-means cluster analyses performed. Therefore, k-means analysis was again chosen for interpreting for the presentation and functionality portion of the questionnaire.

From ANOVA of the cluster memberships, questions 2, 3, 8, 9 of the presentation section and questions 2, 3, and 4 of the functionality section appeared diagnostic of differences between clusters. The clusters differed mostly on preferences concerning on the consistency of wording, distracting information, unknown errors, and difficulty/annoyance while using the VC.

Cluster 1: Negative attitude for presentation and functionality

The first group of participants had a negative attitude towards the presentation and functionality aspects of the VC. They disagreed with the statement "The titles and headers are worded consistently throughout the website" (presentation item 2) and agreed that "there were irrelevant and extraneous materials on the website that [they] found distracting" (presentation item 3). They also disagreed with the statement "In the event of an error, there are helpful solutions to solve the issue" (presentation item 9). The amount of work spent on looking and searching for relevant pages were high (functionality question 4), which caused the subjects not to be able to perform tasks and accomplish goals efficiently in the VC (functionality item 6). However, surprisingly, cluster 1 members were pleased with the screen layout -- they agreed with the statement that "The screen layout of the website is appealing" (presentation item 4).

Cluster 2: Neutral group for presentation and functionality

Cluster 2 members were between the other two clusters in terms of attitude. They were satisfied with the presentation and functionality of the VC. The workload for them using the website was low, and most of the other responses were neutral.

Cluster 3: Dislike presentation and required effort to use VC

The third group found the VC hard to use, mostly because of screen layout and unknown errors without proper advice. The ratings for effort and difficulty in using the VC were above average (functionality items 1-3). They disagreed with the statement that "The screen layout of the website is appealing" (presentation item 4). They strongly agreed that "There are unknown errors without proper messaging" (presentation item 8) and strongly disagreed with the statement that "In the event of an error, there are helpful solutions to solve the issue" (presentation item 9).

1.2.3 Comparing the 3 cluster analyses

As mentioned in the section above, k-means cluster analysis seemed to provide more consistent cluster groupings than did Ward's method for this set of questionnaire data. Even so, the clusters obtained through k-means analysis were not identical for the three analyses performed, i.e., one with all questions, a second one with structure and navigation questions, and a third one with presentation and functionality questions.

The three clusters obtained by k-means analysis are listed here again[3]:

	Cluster 1:	Cluster 2:	Cluster 3:
Overall	1, 3, 5 (negative)	2, 4, 6, 8, 11, 15 (positive)	7, 9, 10, 12, 13, 14 (positive)
Structure/navigation	1, 3, 5, 13 (negative)	2, 4, 6, 7, 8, 9, 10, 12 (positive)	11, 14, 15 (neutral)
Presentation/functionality	1, 3, 5 (negative)	2, 4, 7, 8, 9, 10, 12, 13, 14 (negative)	6, 11, 15 (neutral)

Table 8 : Cluster membership for subjects for all cases using k-means method

The different groupings between the three analyses were due to the differences of the significance of particular questionnaire item in contributing to the cluster membership. Some of the questions

[3] The clusters are labeled in numeric order according to the cluster numbers provided by SPSS. The numbers do not signify equivalence of cluster across the three analyses.

were significant in the F-test with cluster membership for the overall analysis, but were not significant for the subsection analyses, or vice versa. This finding showed that there was a difference in how the clusters were formed with different sets of questions.

The way in which the participants had been clustered indicated that some participants liked some aspects of the site, but not other aspects. In the two subsection analyses, subject 14 was placed in the neutral cluster, but was placed in the less experienced but positive cluster in the overall analysis. This subject felt neutrally about all aspects of the VC. Subject 6 was in the positive cluster for overall and structure/navigation analyses, but was grouped with the negative cluster for presentation/functionality analysis. This subject was satisfied with the VC as a whole, but disliked the presentation and functionality of the VC.

Some participants were always grouped together in the three analyses. These participants behaved as a group of their own. Comparing the clusters formed, only the cluster 1 members were relatively stable across all three analyses. Subjects 1, 3, and 5 stayed in the same cluster grouping throughout. Cluster 1 in all three analyses contained participants who had negative opinions on the VC; therefore these three participants were not satisfied with any of the aspects of the VC that were assessed in the questionnaire.

Subjects 2, 4, and 8 remained together for all three analyses; they were in the positive attitude group for the overall analysis and S/N analysis, and in the neutral group for P/F analysis. These three participants were satisfied with the structure and navigation of the VC, but were uncertain about the presentation and functionality of the VC. In the overall analysis, these participants were grouped with members who did not like the layout, even though they were pleased with the organization. This finding agreed with the positive tendency in the structure and navigation analysis (cluster 2), and the neutral tendency in the presentation and functionality analysis (cluster 2).

Subjects 11 and 15 also remained in the same cluster in all three analyses. These two participants had different preference in the two sections of the questionnaire. They were grouped with the neutrals for the structure and navigation analysis (cluster 3), and they were grouped with people who found the site hard to use because of little useful guidance in the P/N analysis (cluster 3).

For the overall analysis, these subjects were in the cluster that did not prefer the existing screen layout, but were pleased with the organization of the VC (cluster 2).

Subjects 7, 9, 10, and 12 were grouped together for the three analyses. Since they tended to respond neutrally in P/F analysis and positively in S/N analysis, it was reasonable to group them into cluster 3 for the overall analysis, where these participants tended to be positive towards the VC.

Subject 13 was an interesting case. This subject was in the positive cluster for overall analysis, neutral cluster for P/F analysis, and negative cluster for S/N analysis. Subject 13 felt negatively towards the VC's structure and navigation (cluster 1), but was neutral on the presentation and functionality of the VC (cluster 2). In the overall analysis, subject 13 was grouped with the positive group (cluster 3). Since subject 13 was grouped in cluster 3 overall; this subject's dislike in the structure and navigation of the site was not as significant. Subject 13 was only weakly associated in the negative cluster for the overall analysis, since the distance of subject 13's mean preference value was furthest (2.96) from the group's mean, where as the others subjects' values (1, 3, and 5) were 2.78, 2.29, and 2.29 respectively.

2 PERSONAL INTERVIEWS

The previous section discussed the analytical part of the results. This section will discuss the interview findings. The interviews followed up on issues raised in the questionnaire and other problems the participants discovered. Interview results were summarized and grouped below by the categories: structure, navigation, behaviour, user control, presentation, and functionality.

2.1 Interview summary

2.1.1 Structure

The minimized overview map and the 'path' were useful to know where one is in the VC (Figure 4). However, other users did not see much use in this map, other than taking up real estate, since their location of the site path was not shown on the map nor on the project list (Figure 5). The VC was organized into different sections, and some sections could assist collaboration with other non-project members. For example, a member liked the idea of the "pub" as a good place to 'talk' to others members or visitors, either for leisure or research. Even though there was an

introductory section in the site to describe the site and some of its functions, some members still thought the purpose of the VC was not clearly expressed.

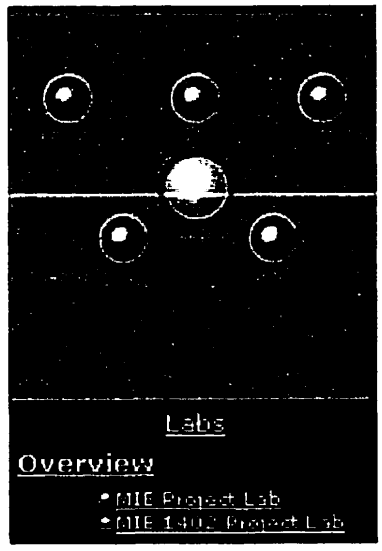

Figure 4: Overview map

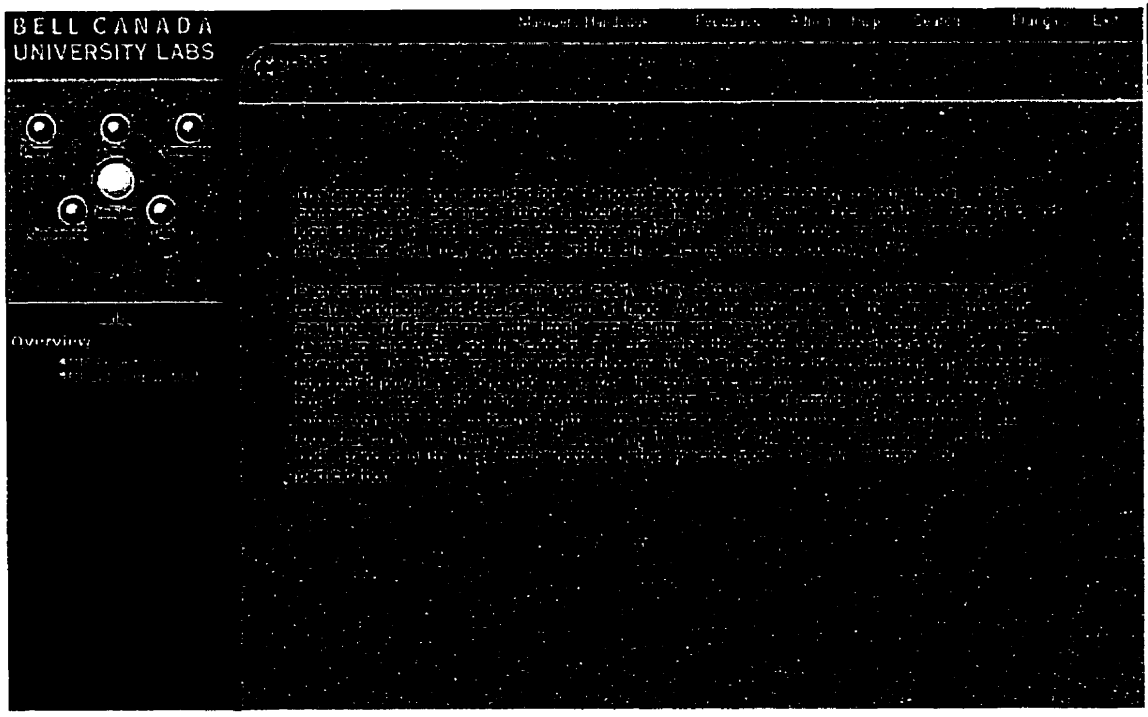

Figure 5: Introductory screen in the *Labs* section, overview map, and path

A login was not required to view the public part of the VC, but special access was needed for other private information on the site. By only showing the public part, the VC appeared empty,

and visitors lost interest in exploring it. It was not obvious that a login was required or that there were more materials for sharing *if* you were a member of the VC (Figure 6). Members could not see information and others using the site. There did not seem to be sign of activity in the VC, but such activity was just hidden behind a security shield. VC members and visitors wanted to know if there were actually others using the website!

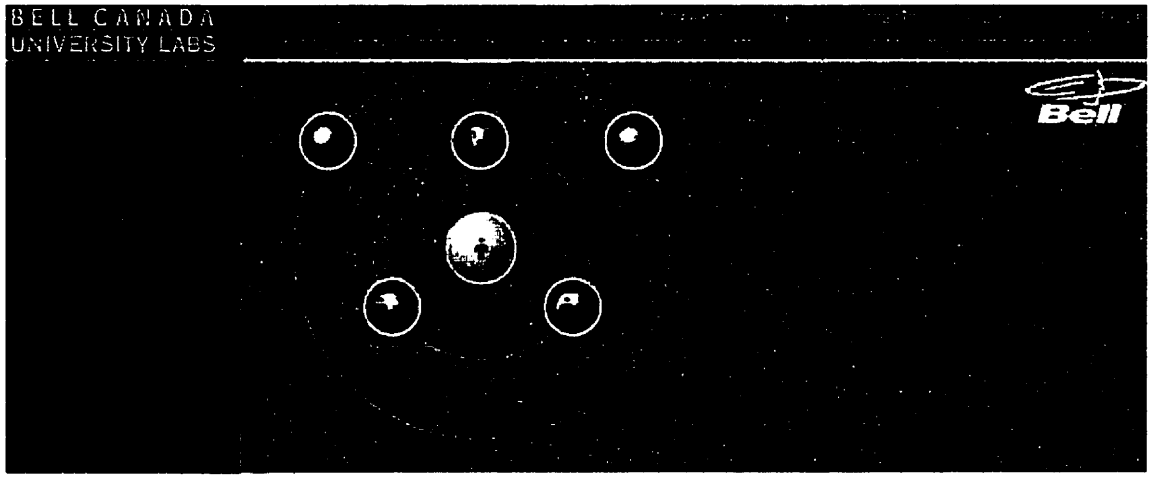

Figure 6: Website's main screen

Since all layers of the site were of the same colour, there seemed to be an orientation problem. With the same colour on all levels, it was difficult to know a user's depth in the VC. This situation made it even harder to find a file it was necessary to dig through random layers. One member complained that he was "...frustrated that I need to look too long to find a specific file". In contrast to some interviewed members, a few said it was hard to see where they were at the site even though the path was displayed in text (Figure 7). This problem arose because the path was presented in text, not graphically, thus increasing users' cognitive workload in making sense of where they were located.

Figure 7: Listing of the path

2.1.2 Navigation

Some members commented that navigation of the site was easy and it was straightforward to get from place to place. The view of the path gave a clear sense of where they were currently (Figure

7). The overview map allowed them to jump to other sections of the site easily (Figure 4). In contrast, a majority of members complained it was difficult to go directly to a specific location in the VC. It was very cumbersome to login and click through several layers of links to get to the desired location. For example, several members mostly used the document publishing function. They wanted to get that particular section without having to go through much clicking. The steps to arrive at *Document Publishing* section of their project group were:

1. Go to site's main screen (Figure 6) and login (Figure 8)
2. Click on *Labs* (Figure 9)
3. Click on a lab (Figure 4)
4. Click on the *Projects* tab
5. Click on a project (Figure 10)
6. Click on *Workspace* button
7. Click on *Document Publishing* link (Figure 11)

Each time, members had to go through these seven steps to reach to their section of interest!

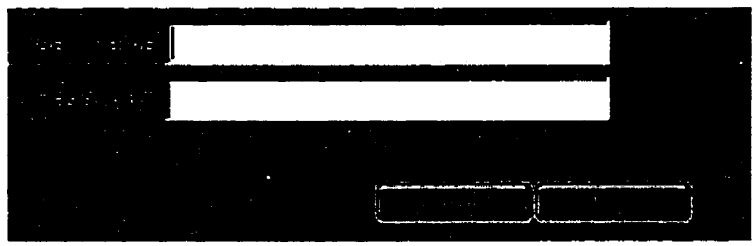

Figure 8: Login screen

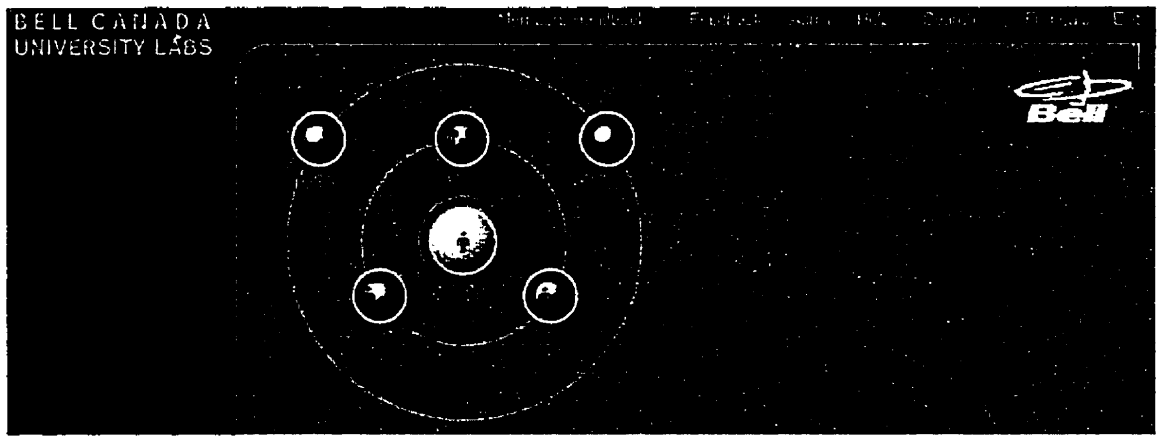

Figure 9: Screen after login completed

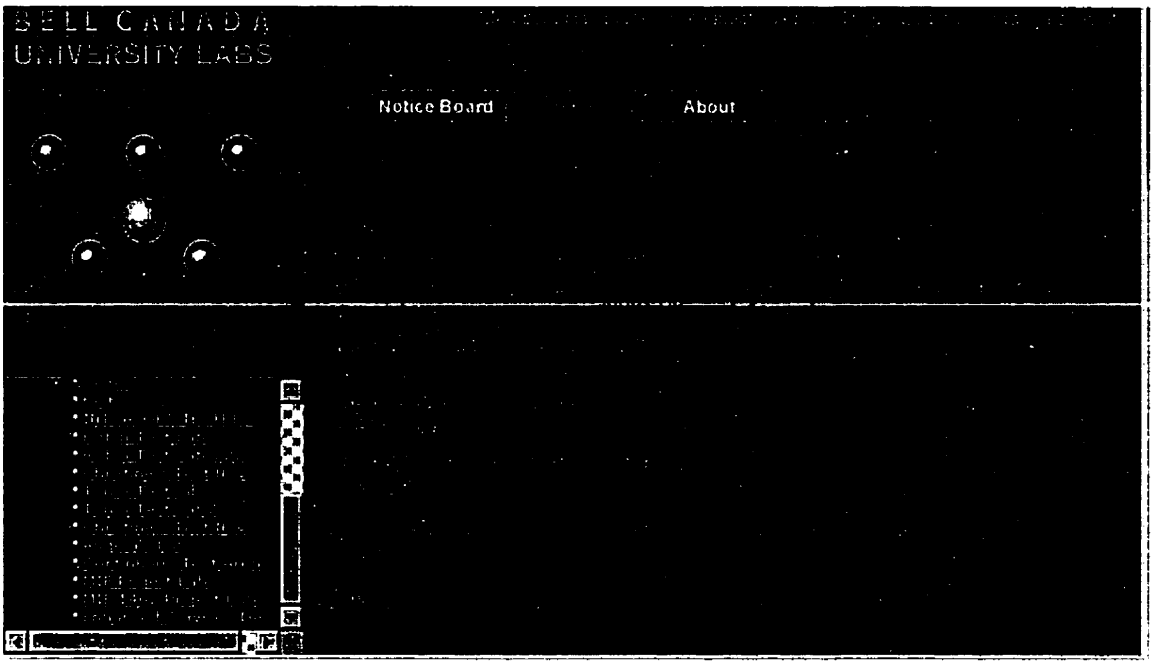

Figure 10: The *project* tab

Figure 11 : The *Workspace* within the project

2.1.3 Behaviour

The pages of the website generally behaved as members would expect, and pages loaded in a reasonable time. However, some members were unclear on some terms used in the VC, e.g., *Commons*, *Pub*, *Lab*, "set thread", "check in/out". This uncertainty could be due to users' limited experience in this setting.

Sometimes members received a certain set of options, but a different set would be presented at other times for links on the same section (Figure 12). When members were uploading a file, the default file type from the windows open dialog box was 'html', which was usually not the required file type. The "Cancel" button on the upload page would often return to an operation many steps back, or even jump out of the project section (Figure 13).

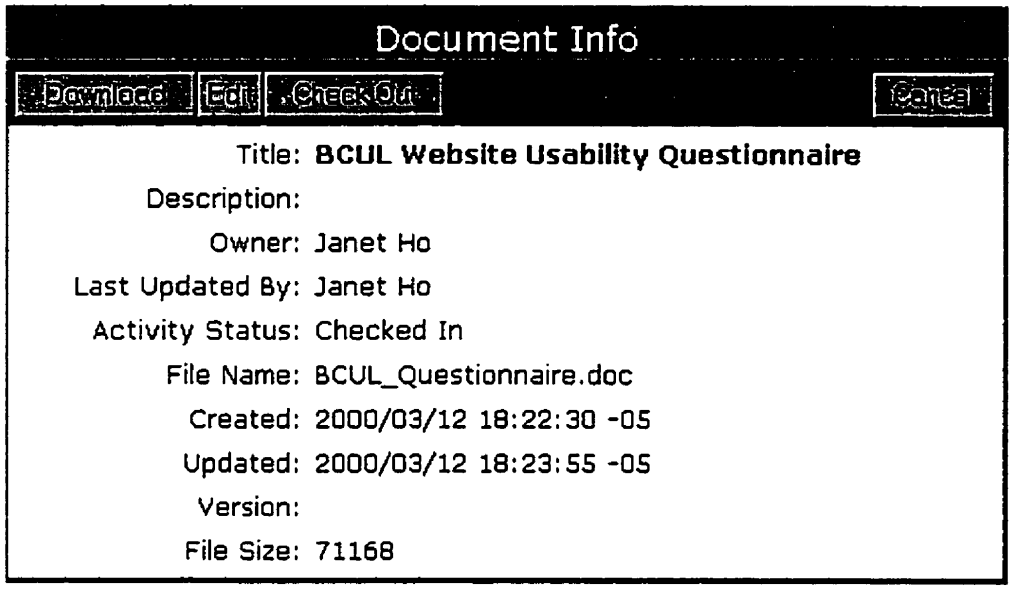

Figure 12: After clicking on the document name link[4]

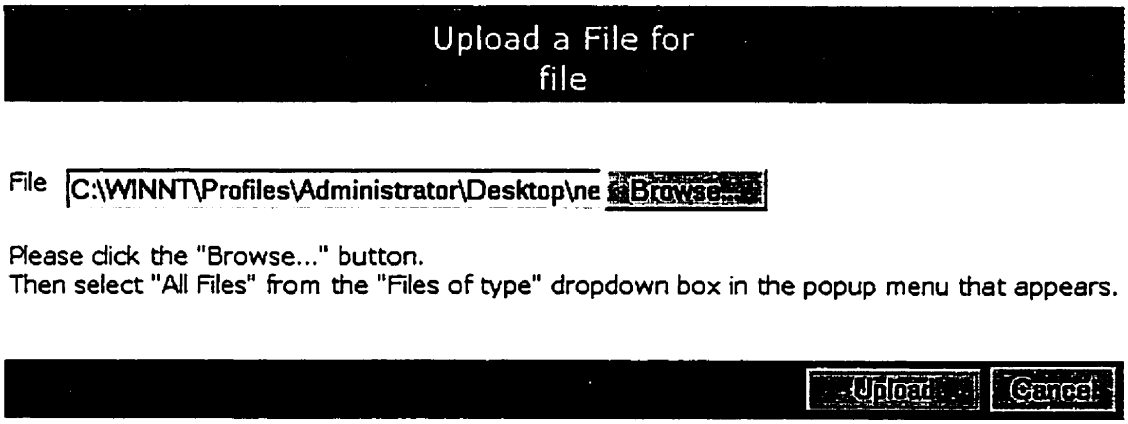

Figure 13: Uploading a file

There also appeared to be random server problems. The connection appeared slow for most of the time, even when members had high speed Internet or LAN connections; the slow connection

[4] NB: The names appearing in the screen shots of this chapter has been modified due to privacy.

caused the pages not to load properly. A "transfer interrupt" often flashed in a certain frame, even if a member had not halted an operation (Figure 14). Since members had to wait some time for an operation to complete, they often lost their train of thought.

Figure 14: 'Transfer interrupted' appeared when the user has not done anything to stop an operation

2.1.4 User Control

Members were not able to correct or delete their own mistake in certain parts of the VC. For example, if they had mistakenly posted a deliverable or a discussion item, it was not possible to edit or to delete the item. Moreover, in lab/project management, even the person who created the lab/project was not able to delete a mistakenly created or expired lab/project. Moreover, when members sometimes forgot their own passwords, they could not get help in obtaining or resetting their password, so they often chose to re-register as a new user.

2.1.5 Presentation

Almost all interviewed members liked the aesthetics of the website in general; the icons and pictures were done professionally. However, the choice of the colours was not appealing to all. The contrast between the blue-green background and the text was not strong enough. The text was difficult to read, especially after a visited link (e.g., a project link list on the bottom left) (Figure 4). The font size was too small for the introductory screen and the project selection links (Figure 5). Even though the graphics were appealing, their load time lengthened a user's wait time for accessing contents of the VC.

Unfortunately, online help was not yet available. Members had nowhere to turn for help when they were unclear about some function, which was very possible in this version of the virtual community. Moreover, there were error messages that appeared without explanation; this confused the users further! The members thus tried to click the 'help' button but found it unavailable.

The website did not provide enough status information for users. For example, during a file upload or download, there was no indication of progress; the screen remained as in Figure 13. The screen appeared as though nothing was happening, but the upload/download was in progress. Users had to wait until the file transfer was complete, without knowing the length of the transfer or the percentage of the file already transferred.

There were quite a number of small usability problems on the web pages. For example, when users scrolled in a section of the frame, the action buttons followed the scrolled text and disappeared with the top of the text. When uploading a file in the document publishing section, filename and description were required fields, but they should be made optional (Figure 15). Moreover, if the filename entered was the same as an existing file on the project folder, the system automatically renumbered the file name without verifying it. The "exit" button in some sections of the 'Admin' function was inappropriate. When listing lab names, users did not have to 'exit' (label on the button), but rather return to the previous page when they had finished looking at the listing (Figure 16).

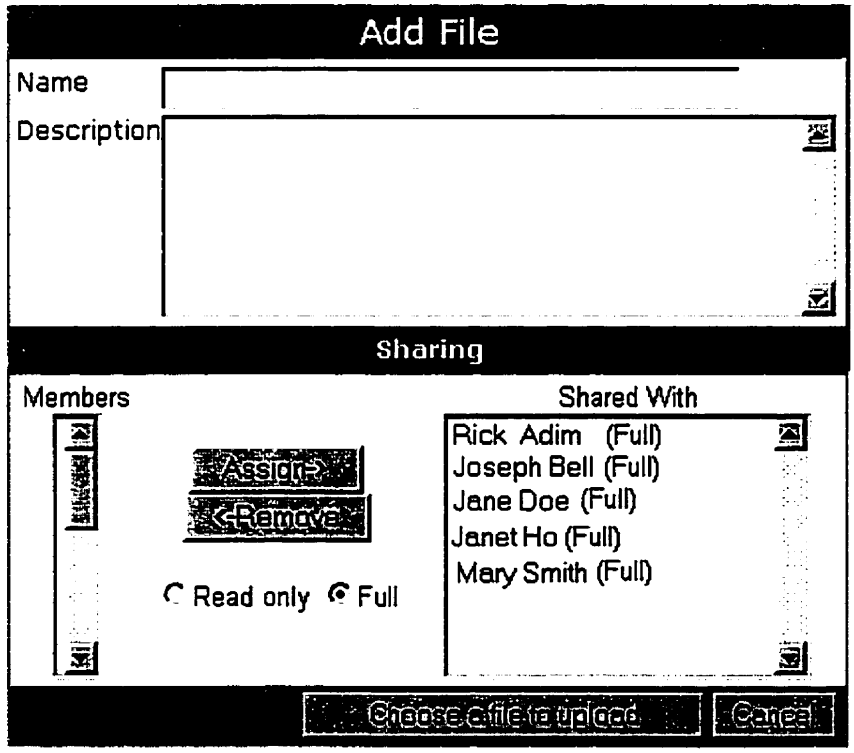

Figure 15: Dialog box to fill out before uploading a file

Figure 16: Inappropriate 'exit' button in the 'Admin' section

2.1.6 Functionality

The features in this version of the VC attracted most members to continue using the VC for their other group projects and users would recommend the site to others. This was an integrated place for chat, file exchange, file sharing, scheduling, etc, and what one member termed "one-stop shopping". Users could keep things in one place and did not need several tools. The web-based capability of the VC made it accessible behind corporate firewalls, which may not be possible for many school newsgroups. Members knew which was the most up-to-date document (time stamp) and who last edited that document (Figure 17). If an update of a file was required, only a single update was required at the central file sharing space of the virtual community, without emailing the file to the whole group for update. Even if emailing was required, the VC had the needed functionality.

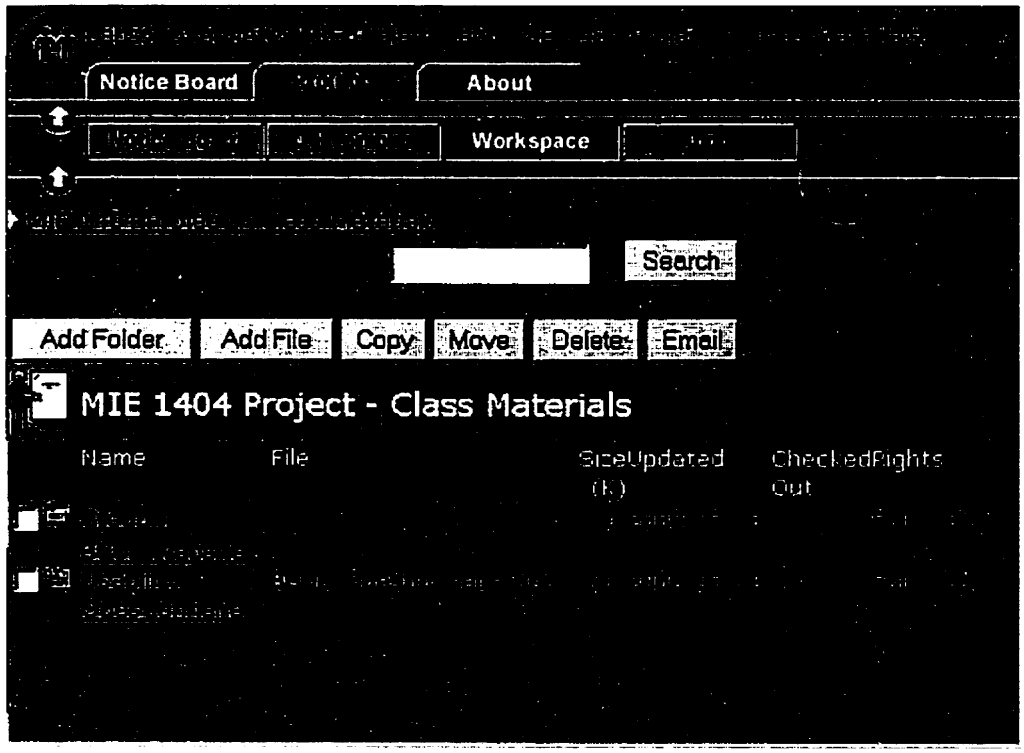

Figure 17: In the *Document Publishing* section in the project space

When a team leader added a new project member, the leader was not able to distinguish the member when more than one user has the same first and last name (Figure 18). Even in the user information, there was no relationship between user login name and the person's displayed name.

If a group member checked out a file, the file should have been read-only until the file was checked back in. Often the first member forgot to check in a file after modification; therefore some reminder was needed for the first member to check the file in within a certain period.

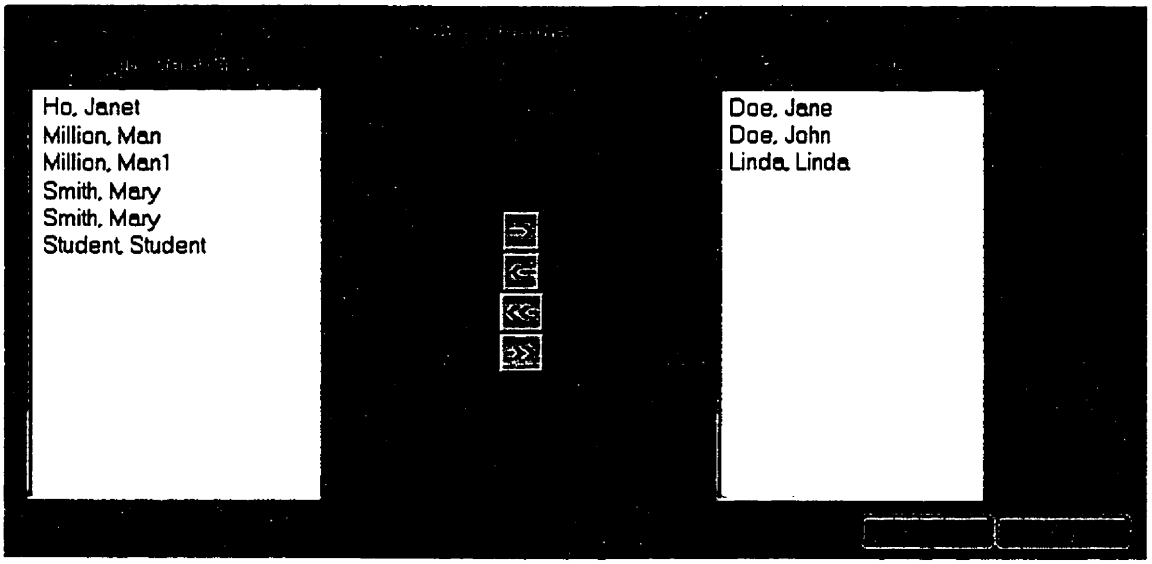

Figure 18: Adding user to project. Issue when users have same first and last name!

Sometimes emailing other members of the project group was necessary for certain tasks. Email was supported only in the document publishing section; it could be expanded in other sections such as *Noticeboard*, etc. During emailing, users could select from a list of members' email addresses associated with names, since entering one's email address is requested during registration. In this sense, it is reasonable to know who else is in your lab/project group, and to be able to click on a name to get addition information, such as background, research interests, etc.

One interviewee was a team leader who had created a group on the site. This member complained that he had to search through a long list of users on the site to find out his "people", i.e., new registered members of his group. After adding new members to the list, the team leader actually had to separately notify them of the addition.

2.2 Participants' recommendations

Since the participants encountered problems using the VC, they would like to see modifications based on some of their recommendations. The VC must make it obvious that a login was required to gain access to more information in the VC. For visitors, a guest login led them into another part of the site where there would be sample groups and examples to show the functionality and capabilities of the virtual community. A demo of the VC was needed. Such a demo would allow visitors to feel a sense of community. There had to be an "indication of life" on the VC. One method was to have a list of project members who were currently online, or perhaps all members online in the public part of the site. Similarly, when one walked into a meeting room, one would want to know how many people were currently there, even though they might not be talking to each other.

Different colouring of webpages was recommended for moving through different levels and layers of the VC to ease orientation. Therefore, different colours would represent different parts of the site, grouped by functions. The members could tell from the overview graphs and links which part of the site they were in, and their path could be shown on the picture. The left side of the frame could be hidden to save real estate for the main portion of the page, which was generally used. The left side window should also exist during the administration function, so that after editing a project, a member could return to the main screen.

The addition of some short-cuts, macros or hot-keys would be convenient for the members, especially for experienced members who want to do a specific task instead of browsing the VC. Several members suggested having a "Windows Explorer" type navigation style, where a user would click on a plus sign beside a lab to see available projects, and click on a sub-directory to go to a specific folder or file. Moreover, members liked being able to bookmark a specific page where they left off, so that they could resume their previous activity.

Explaining the general terms used in the website was important to get members comfortable with participating in the VC, especially visitors shopping around for a suitable VC. For example, some visitors did not understand the meaning of "register". It might have meant registering the current software through the Internet, instead of becoming a new member of the community. Also, it is preferable to be able to bookmark or remember the part of the website where a member

last visited, and to notify them if there are updates in that section. When members posted a notice on the *Noticeboard* section, there was no default recipient list. If members forgot to add themselves to the list, they were not able to view or delete the notice. Thus, the VC should be friendly and forgiving, allowing members to go back and correct their mistakes.

A "forget password" option should be provided so members could retrieve their passwords given proper identification. Another alternative was that the administrator of the VC be allowed to reset the members' passwords.

The usability of the web pages must be improved. More status messages about ongoing operations and other types of feedback were required. Users wanted to know if a mouse click caused a valid operation. For example, when uploading files into the shared area, a member suggested "to have a meter or slider type of indicator or a percentage window or a bytes transferred window..." to show that the file was actually being transferred and not that there was a server problem or lost connection.

The site needed to be more "homey" and possibly customizable. For example, at the login screen, the cursor was ready at the username textbox, and the return key was equivalent to clicking on the "next" button. Different colours could be selected according to preference. The working space could vary in size or can even open in another window in full screen. It was preferable to have a "what's new" or most updated file information to inform the users once they logged on about what had changed since the last visit.

All of the interviewed members used the site primarily for document sharing and occasionally to organize group activities. Therefore, most members wanted to see others using the VC, especially those who were in the same lab/project group. In the evaluated version, members entered an environment and worked separately. For example in the *Pub* section, those waiting for chat should receive some form of notification, such as sound or a banner, when new members entered the environment. Since the most popular feature was *document sharing* (described further in section 3 of this chapter), there could be a version control embedded in the system where members would compare older file versions, or revert to an old file if the new file contains unrecoverable error.

It was recommended that there be a category to search new members who had not been assigned to a lab or project. Another option was that during registration, new registered members could enter which lab/project they want to join and request membership from the lab/project leader. There could be an automatic feature that notified new members with a brief introduction to using the features of the virtual community.

Finally, members wanted to see some type of personalization or customization in the VC. Members preferred to be able to go to their "home" page once they logged in, e.g., to start with the calendar or the project section. The users could then make appropriate changes to settle him/herself into the virtual community.

3 SERVER LOGS STUDY

The questionnaires and personal interviews in this evaluation study provided subjective ratings from users of the VC, the server log study, described in the following section, provided objective results and was able to identify the actual usage and navigation patterns in the VC.

3.1 Results

3.1.1 Login duration

Discarding all logins that were shorter than 5 minutes, during the 6-month period from September 1999 to March 2000, there were a total of 161 logins. The average login time for users in the period was 17.6 minutes, where the longest login time was 79.68 minutes. Total number of minutes logged in to the site across all users averaged 404 minutes per month. As shown in Figure 19, November was the most popular month with total session length of 1500 minutes for the month. The times when members logged in and out were searched and recorded from weblogs using a Perl script. The weblog showed 'Logon.asp' and 'Logout.asp' for successful login and logout respectively. Idle time of more than 20 minutes was considered to end a session, i.e., a logout. The difference between matching logins and logouts was the duration of the session. This calculation was done assuming there only one member used the VC at a time. This assumption held because usage of the VC was so low that the chance of having two or more members accessing the VC at one time was small.

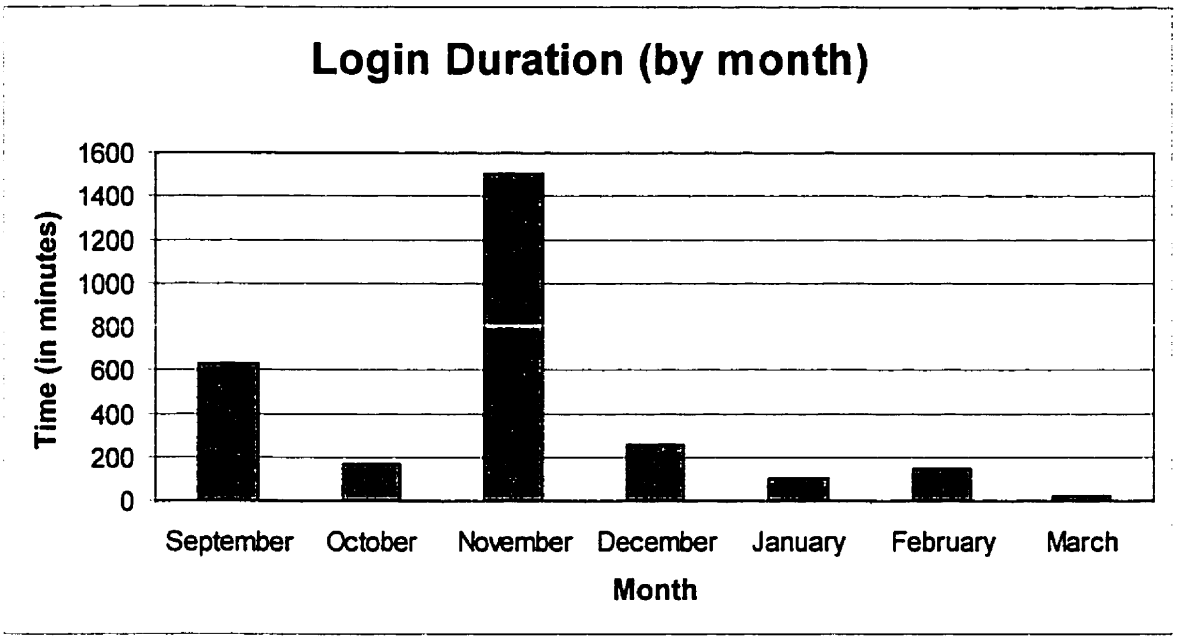

Figure 19: Login time duration

3.1.2 Usage count and time

The usage time and number of accesses for twelve features were recorded. When activating each of these twelve features, a specific active server page (ASP) file was called (the VC was written with Microsoft's ASP), which could be tracked using a Perl script. The access to the particular feature were counted whenever a particular ASP was recorded in the weblog. The usage time was the difference between the access time of the current feature and the next feature. It was assumed that members stayed on a particular page when using the feature, and went to another feature when not using the previous feature. Usage time also included access time without a login. This was necessary because non-registered users were able to browse through the public part of the VC, which included the *pub*, *commons* and *conference* sections. Both the *pub* and *conference* sections were discussion forums, where the former was a free-form discussion and the latter was a public research collaboration chat space.

Document Manager included all sections in the VC where members could publish, edit, and download document files and folders, e.g., in the *document publishing* section in the workspace and *Library*. *Discussion* referred to all conversational interactions within the virtual community. This included activities in the *Pub*, *Conferences*, and *Discussion* in the project workspace.

Calendar was the feature for organizing shared schedules online. *NoticeBoard* represented all notices posted both in the lab and project levels. *About* referred to any descriptions or information of the project/lab/feature in the virtual community. *Administration* counted the times that administrators edited member privileges, and performed tasks such as adding a new project or lab. *Member's handbook*, *feedback*, *search*, and *help* counted the number of times that members used the corresponding buttons on the menu. *Commons* and *Conferences* referred to the number of times that members went into the commons or conference section respectively. The percentage of the usage is shown in the following table (9) and figure (20):

Document Manager	28.62
Discussion	5.37
Calendar	8.63
Notice Board	5.22
About	26.28
Administration	16.76
Members' Handbook	0.68
Commons	2.17
Conference	0.25
Feedback	1.66
Search	3.88
Help	0.48

Table 9: Total feature usage in percentages

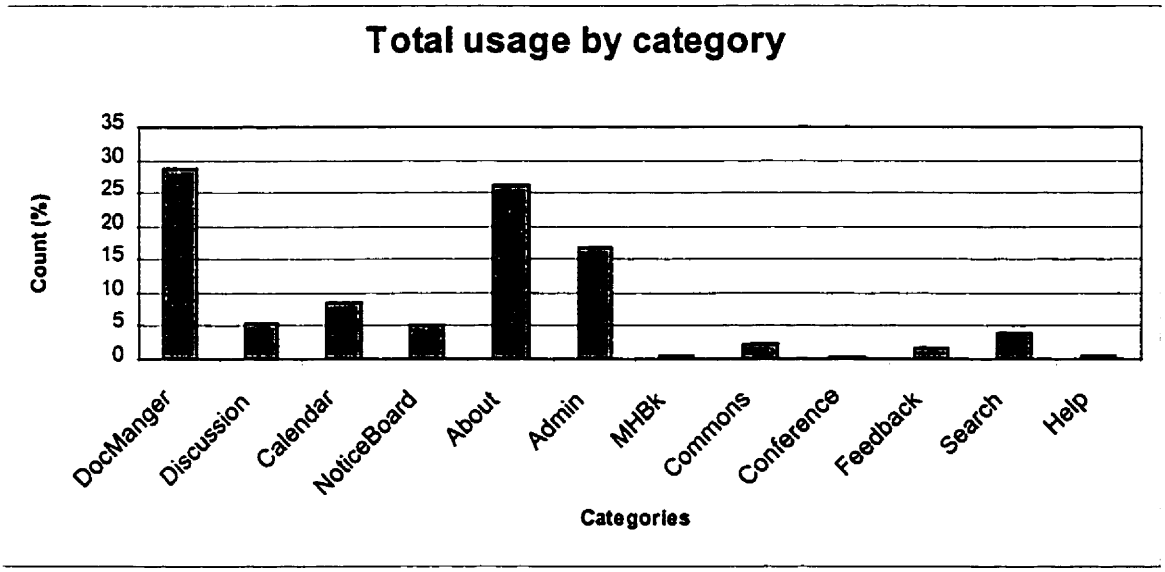

Figure 20: Total feature usage in percentage

The total time in minutes of the usage is shown in the following table (10) and figure (21):

Document Manager	890.13
Discussion	142.67
Calendar	381.37
Notice Board	141.27
About	1114.6
Administration	565.67
Members' Handbook	43.23
Commons	56.27
Conference	6.93
Feedback	242.92
Search	58.7
Help	30.82

Table 10: Total feature usage time in minutes.

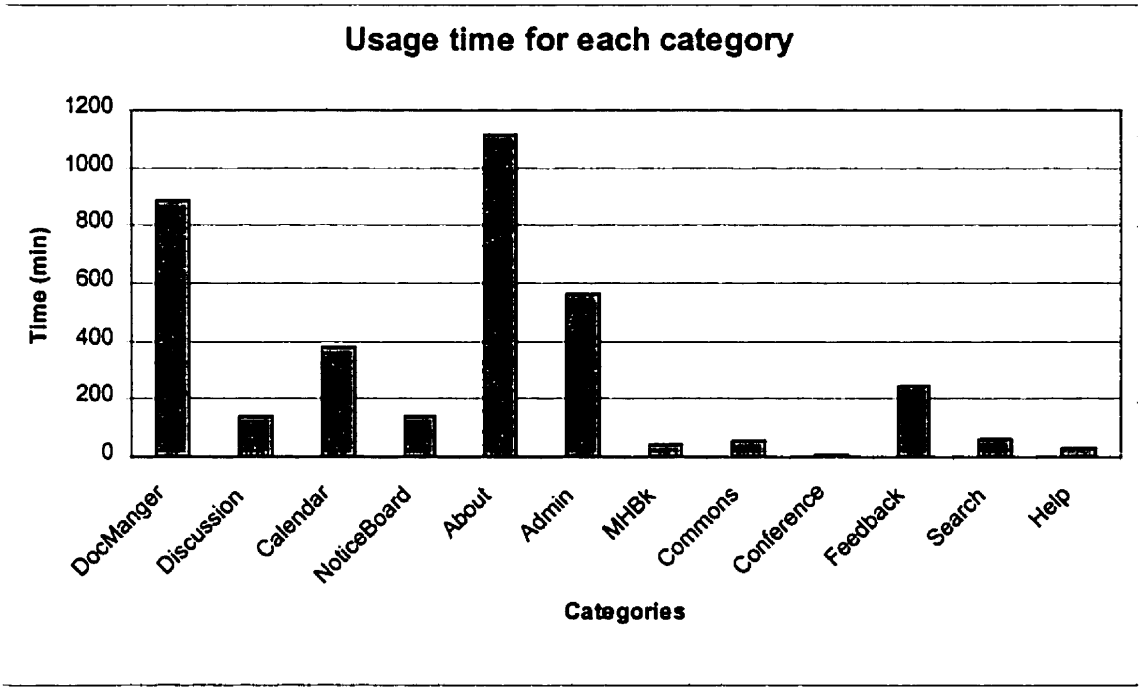

Figure 21: Total feature usage in percentage

3.1.3 Discussion

161 sessions recorded for the user study period over 6 months was a relatively small number. If the number of sessions was averaged out per month, there were only about twenty-seven sessions per month. Moreover, the average duration for each session was less than 20 minutes. Members of the VC did not stay online long using the VC. People did not use the VC for collaboration, but rather as a shared space where files and ideas were shared asynchronously. Since it was

asynchronous interaction, VC members did not have to wait for a new reply since they knew it would not happen instantaneously. This created the effect of short sessions. As mentioned before, session lengths of less than 5 minutes were discarded from the calculation. These short sessions indicated VC members only checking for updated activities in their research groups. They could not reasonably be doing work in such short times.

The login duration for the website peaked at limited times, then tapered off to the average duration of approximately 20 minutes. This phenomenon indicated that users used the VC heavily only during certain periods of time. At other times, there were no logins, or the users only logged in for short periods. The most popular month was November 1999, which held over fifty percent of the total login time in the evaluation period (refer to Figure 19). This was the release time when the website was being advertised internally among the participated institutions. Users were learning the features of the website and 'checking out' the VC. Participation then fell dramatically after this initial period.

Another login period of interest was between January and March 2000 (refer to Figure 19). This was the period when the graduate class was held. A fading login duration was seen once again. The students were first informed of the VC around late January 2000. This was the period when students determined if the VC would be the suitable tool for their mobile computing projects. Only three of the eight student project groups chose to use the VC as a tool for integration. Usage then tapered off after February, returning to the low level of usage that seemed to be more characteristic of the BUL environment during the period of this study. Once again, login duration dropped off after the initial period for the graduate students.

Figure 20 shows that *document management* was the most frequently accessed feature in the virtual community. This was the space where virtual community members upload their work in progress for exchange with other members of the same project group. This activity was perceived as highly valuable, because it meant that a single posting could "deliver" the document to anyone who participated in the project; group members always know where to find the latest version of a document. This value was enhanced by the fact that most members were unwilling or unable to post documents on a Website themselves.

The second most popular feature was *About*. This was the feature where extra information about a section was given. For example, the description of the Library's purpose was written as an introductory section. Moreover, the purpose or goal of each lab and project was described in the About section. Since the VC was in its early development stage, most VC members were new to the community. Members of the lab or project group were not yet familiar with the group and the general purpose of the virtual community itself; therefore it was reasonable for them to browse around the VC and read descriptions to get to know the purpose of a section, thereby using the VC to improve their research collaboration. Figure 21 supports this explanation. Figure 21 shows how much time users spent on each of the twelve listed features. Users spent more time on the about category than the document management category.

The third most accessed feature was the *Administration* category. Similarly, since the virtual community was in an early setup and introduction stage, administration was required to create labs, project groups, and set up the member access rights. Moreover, the virtual community was designed for small team collaboration within a lab, which contained different projects with foreseeable end dates, therefore the setting up of new labs and projects was ongoing.

Figure 21 (usage time) shows a similar pattern as Figure 20 (usage pattern), except for the *About* and *Document Management* features, as explained above. Therefore users assessed a feature only when spending time using it; they did not browse other parts of the VC regularly. They simply navigated to a feature and used it.

4 CONCLUSIONS

The sample size of the data obtained from the three evaluations indicated a low participation in the BUL website. Most participants felt neutral about the usability of the VC. The analysis identified a few points:

1. Some users were consistent in answering different sections of the questionnaire
2. The users could be classified according to their user profile (from their questionnaire responses)
3. There were usability problems in the VC
4. The most frequently used functions were *document publishing*, webpage information (*about*), and *administration*

Performing analysis on only fifteen questionnaires and five interviews was not enough to represent all of the VC members. However, averaging out to less than one login per day, it was difficult to recruit more participants who used the VC actively. The relatively low participation rate in this study could be explained by the prototype nature of the VC. Researchers were unfamiliar with the website, thus they preferred using other means of communication, rather than trying to learn their way around the VC. Moreover, there were a number of usability and functionality issues. A number of issues were raised from the personal interviews. These issues concerned mostly the VC's usability, where a few of the issues were related to the collaborativeness of the VC. For example, there were not enough cues in the VC showing that other participants were using the VC. The VC looked empty, which caused prospective members to lose interest in participating. Since the interviewed groups were small work groups, the VC was able to support collaboration for small-sized groups. The extra peaks in login duration were most likely from visits by potential members of the VC. They want to look at available features, but failed to return for further use. The most popular activity in the VC was *document publishing*. VC members used the VC as a place to share files, but not as a place for collaborative discussion. This findings explained the short duration of each session.

Cluster analyses of the questionnaire grouped participants according to their attitudes towards the VC. The participants were grouped into three types based on their response pattern: one with generally negative views, another with different views in differing aspects in the VC (e.g., liked the site's structure and navigation, but disliked the site's functionality and presentation), and a third type with more neutral attitudes. The participants were consistent in answering the questionnaires; however it was not possible to determine definitively the preference of the users. The responses were more on the neutral side; therefore, the VC was marginally acceptable as a research collaborative environment. Overall, the subjects were not satisfied with the presentation and functionality of the VC. The groups formed tended to have negative attitudes or at most a neutral opinion on these two aspects of the VC. The subjects were more satisfied with the structure and navigation of the VC. The largest cluster group (cluster 2) in this subsection analysis had a positive attitude towards these two aspects of the VC. By understanding these three types of participants, it may be possible to build a customization system based on these distinct properties.

CHAPTER 5

RECOMMENDATIONS

CHAPTER 5: RECOMMENDATIONS

1 USER INTERFACE FOR BUL WEBSITE

Based on the empirical evaluation made on the BUL website, future modifications were recommended for the existing interface. Since evaluation results often help to build a successful VC, redesigning the BUL VC for future users would be important. The following set of interfaces was developed through a user-centered design approach, where the user is the focus of concern. This process should accommodate the goals of the users, helping them to increase productivity and efficiency. The design suggestions in this section are for the Bell University Labs website's design teams to use as their next steps in developing a better prototype.

1. Required login for access

Problem: In the version evaluated, members clicked on the *Login* button to start the login procedure.

Recommended change: The member login dialog box is recommended to be placed in a more prominent location with respect to the screen (Figure 22). Visitors to the VC know that a login is required to access the VC. The buttons on the right hand side of the screen are functional for visitors to enter the public part of the VC.

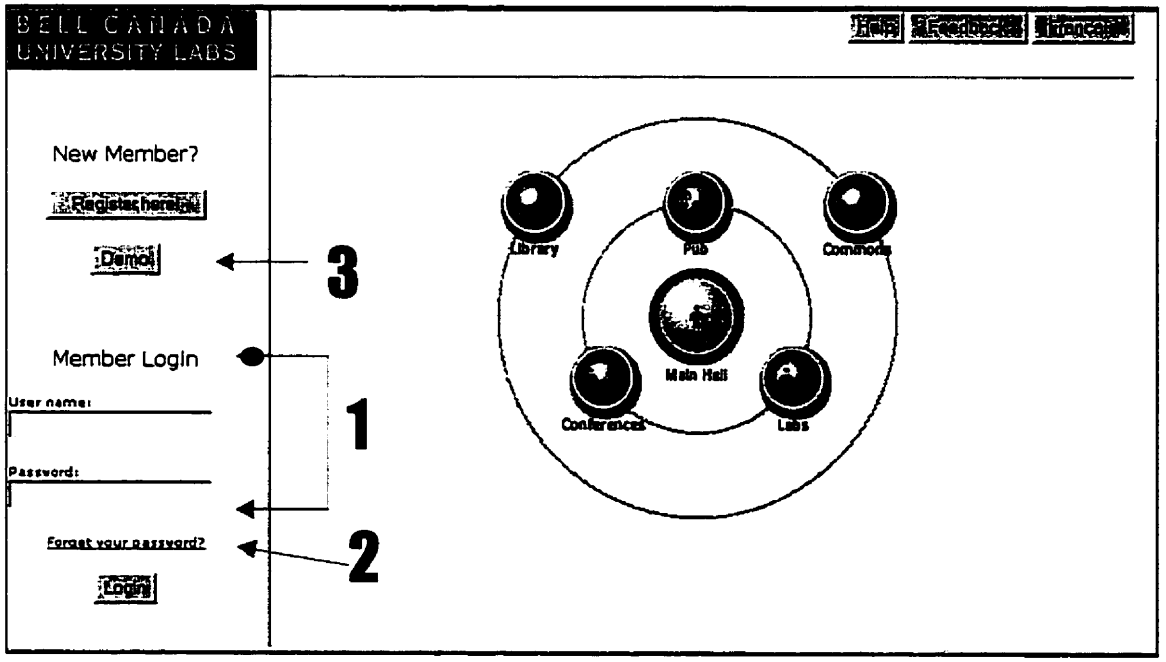

Figure 22: Introductory screen of BUL website

2. Member forgetting password

Problem: Members would forget their passwords occasionally

Recommended change: The *Forget your password?* link (Figure 22) provides either hints to help the members to retrieve their passwords or allow mechanism to let the members obtain a new password.

3. Provide tour of VC

Problem: Visitors were not clear of the functions available in the VC.

Recommended change: A demo or tour of the VC helps visitors to test and see the functions and features of the VC (Figure 22). Visitors can be more familiar with what was available and what can be accomplished in the VC.

4. Modification in new registered members' form

Problem: Often when web surfers were asked to provide their personal information when registering for a site, they filled in the minimum amount of information required. However, some information were useful to the VC's administrator and were mandatory to be filled in.

Recommended change: Symbols are added to indicate which fields are mandatory (Figure 23). Moreover, there is an option for the registering member to enter the name of the lab and project they wish to be part of. This, however, does not guaranteed project membership; the project leader grants the project membership.

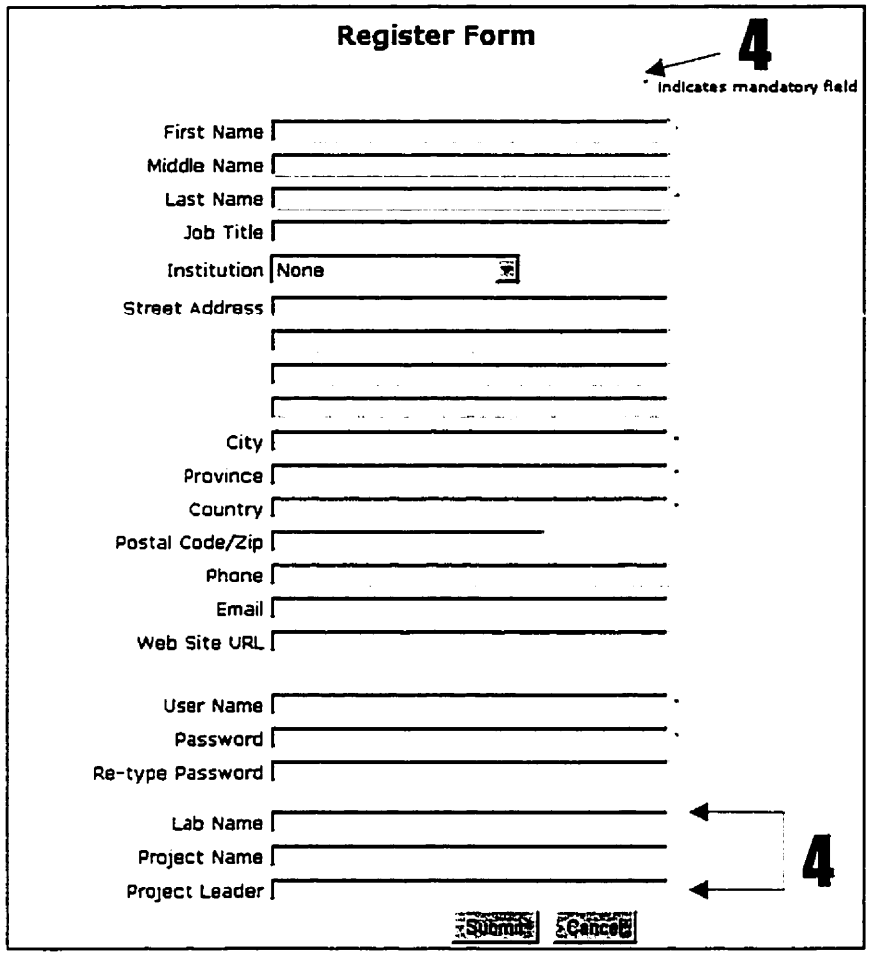

Figure 23: New member registration form

5. Indication of location on overview maps

Problem: Members could not tell where they were from the overview map.

Recommended change: The overview map on the upper left-hand side shows the current location with a different outline colour (Figure 24). Moreover, the lower left-hand frame shows the current function by changing the text attribute to italics and to bold for unread messages (Figure 25).

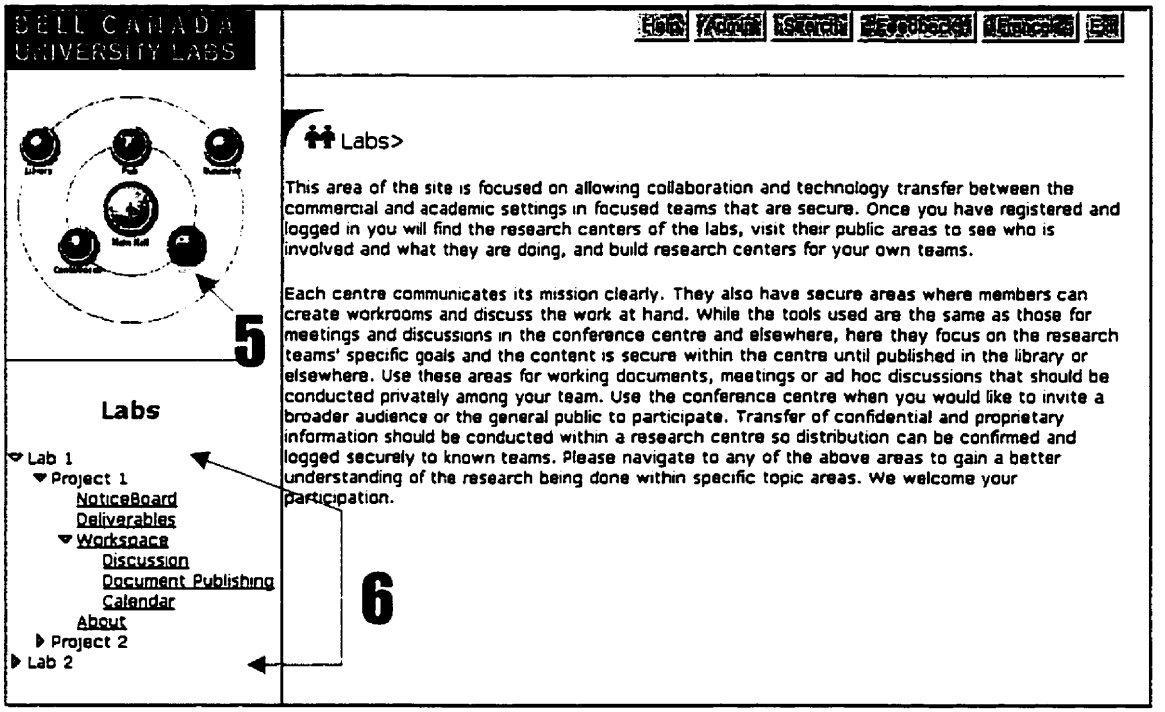

Figure 24: Lab section overview page

6. Convenient access to functions

Problem: Since the most popular feature in VC was document publishing, members should be able to access this feature more readily. In the version evaluated, the path to *document publishing* was hidden under layers of links, as described in section 2.12 of Chapter 4.

Recommended change: The modified interface shown in Figure 24 allows members to directly access the desired features through hyperlinks in the lower left-hand frame.

7. Support for undo and redo

Problem: Members should be able to correct their mistakes.

Recommended change: In the *Noticeboard* (Figure 25) and *Deliverable* (Figure 26), the members can delete messages mistakenly posted or overdue/completed using the *Delete* or *Modify* buttons.

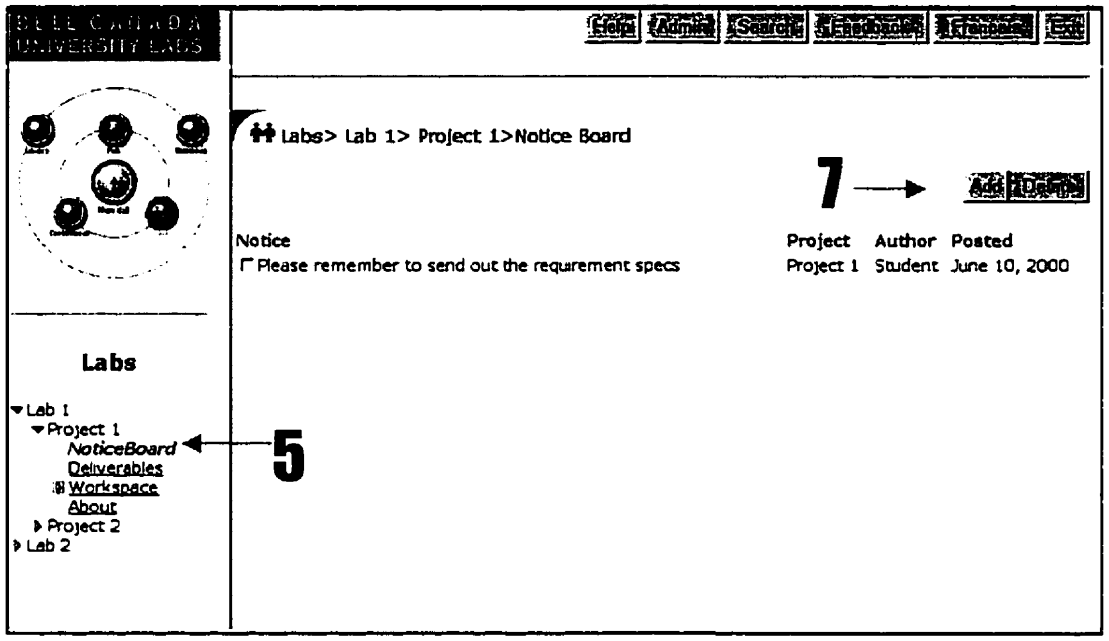

Figure 25: Modified *NoticeBoard* page

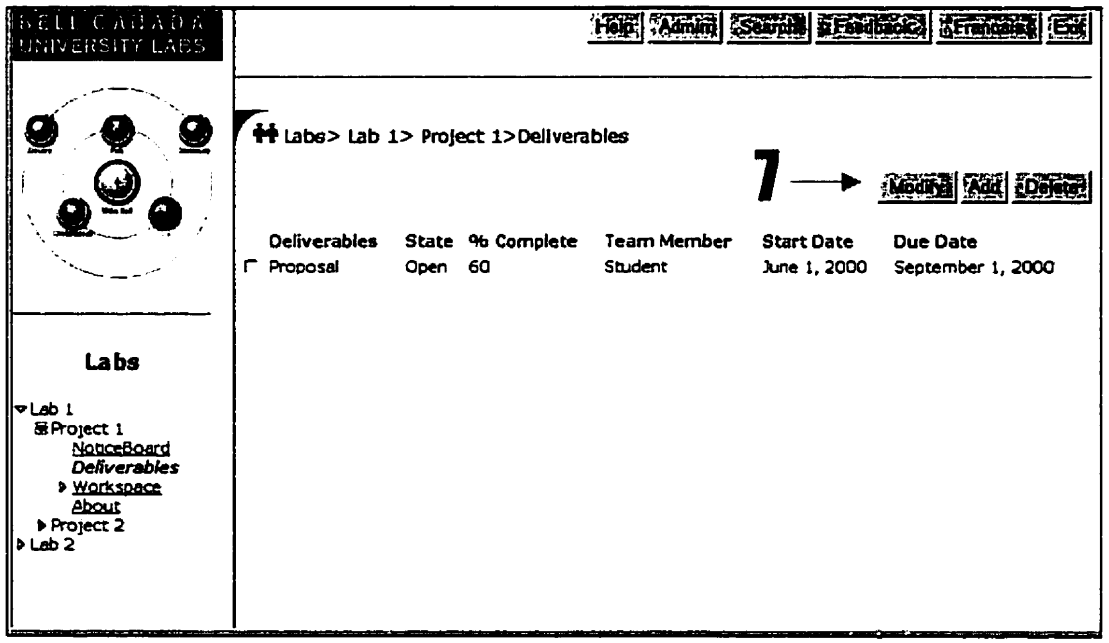

Figure 26: Modified *Deliverable* page

8. Provide version control

Problem: VC members were not able to keep track of who had made modifications on the original copy of a document and were not able to revert back to previous versions of that document.

Recommended change: A version number column is recommended to keep track of the document version VC members were working with (Figure 27). The system will keep the member informed on which version they are editing or viewing. There is also a backup collection of updated documents in which members could back track to older versions for corrections. Clicking on the version column shows the history of the revision and the previous editors.

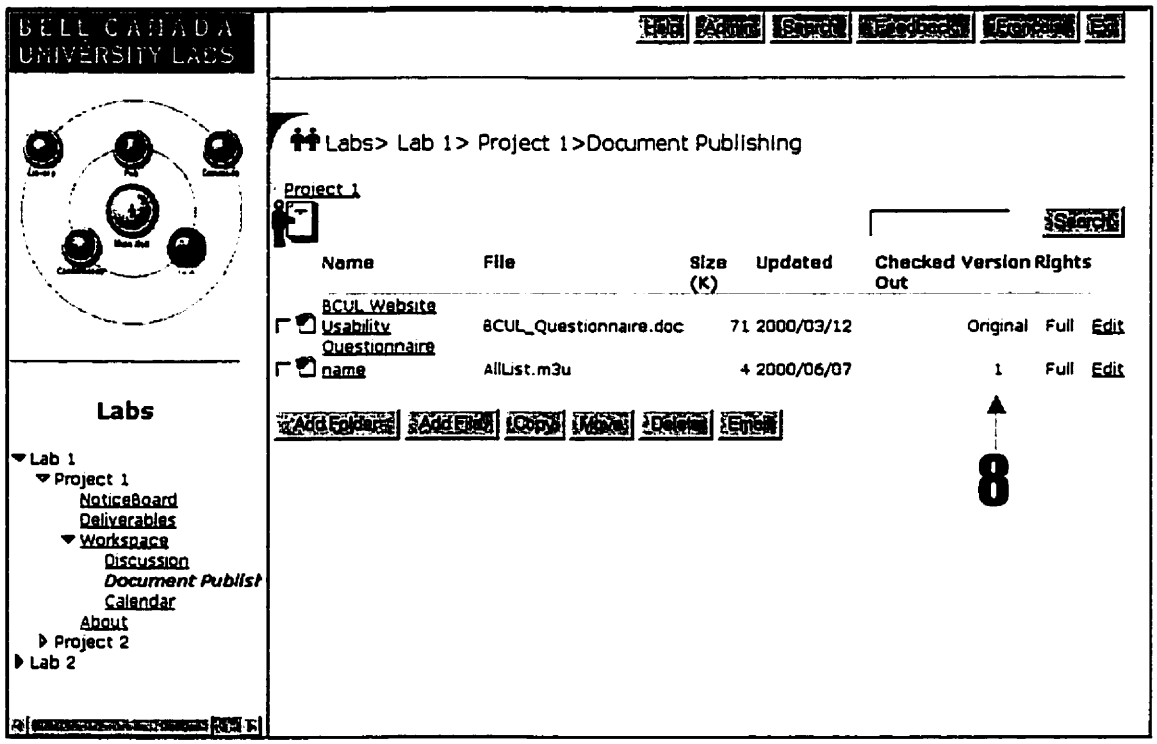

Figure 27: Modified *Document publishing* section

9. Document publishing permission selection

Problem: The assignment of individual member's permission to a file in the *document publishing* section was complex. The list boxes used in the version evaluated were constrained to choose either read or full access to all selected members but not a combination of the two rights. It was not possible to assign some project members with read access and others with full access.

Recommended change: The use of radio button selection (Figure 28) is suggested to assign separate permission to each member. The default permission is *Full*, where the member can read and edit the particular document.

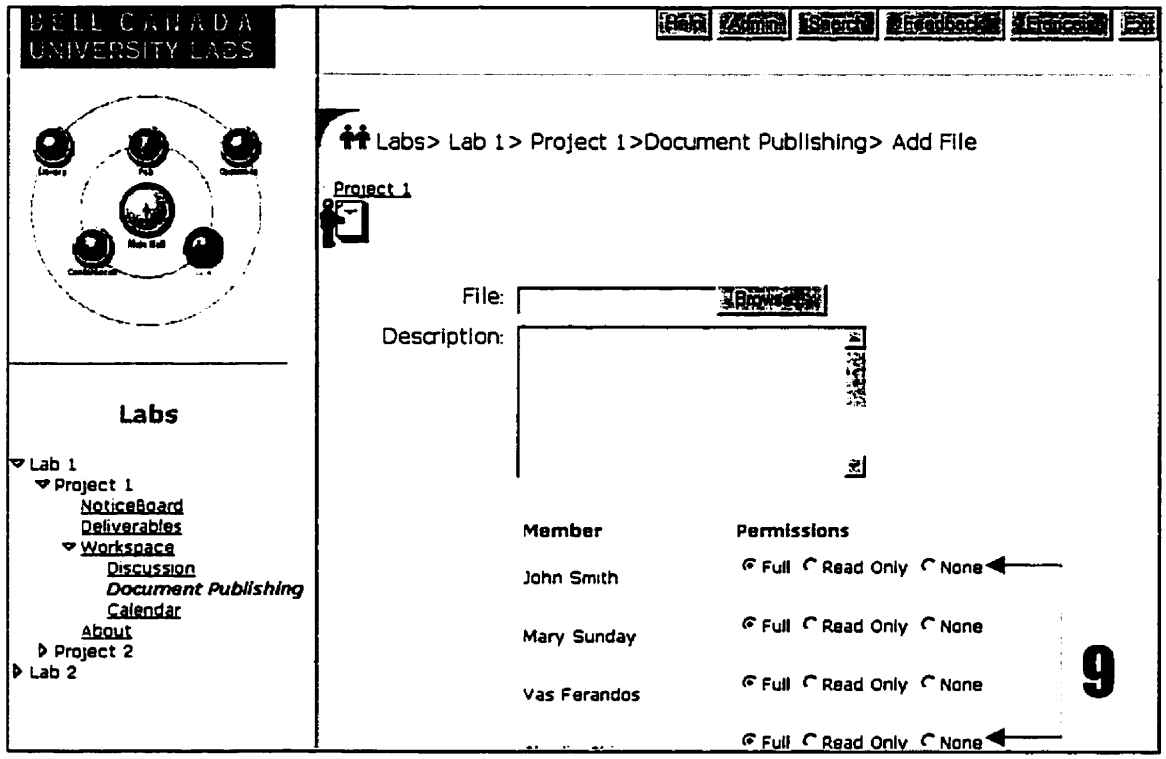

Figure 28: Adding file in *document publishing* section

10. Status message for file transfer

Problem: The members were not informed of the status of the current file transfer. They were not sure if the file transfer was happening and the amount of time required for the transfer.

Recommended change: An addition of a *Transfer Status* dialog box showing an estimate of the length of the file transfer process (Figure 29) is recommended.

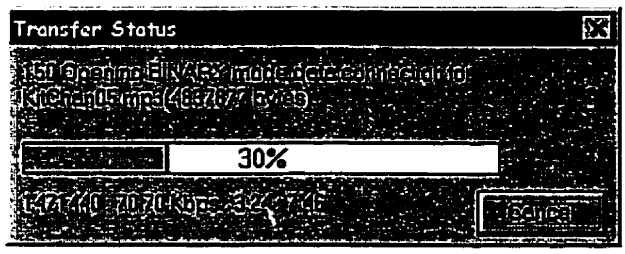

Figure 29: File transfer status box

11. Group email

Problem: Members had to type in the recipients' email addresses even if they were in the same project or lab group.

Recommended change: The proposed change is to provide a selection list of members in the same project(s) or lab(s) as a drop down menu selection (Figure 30). The members do not have to type in the email address for members of the same project when sending group email.

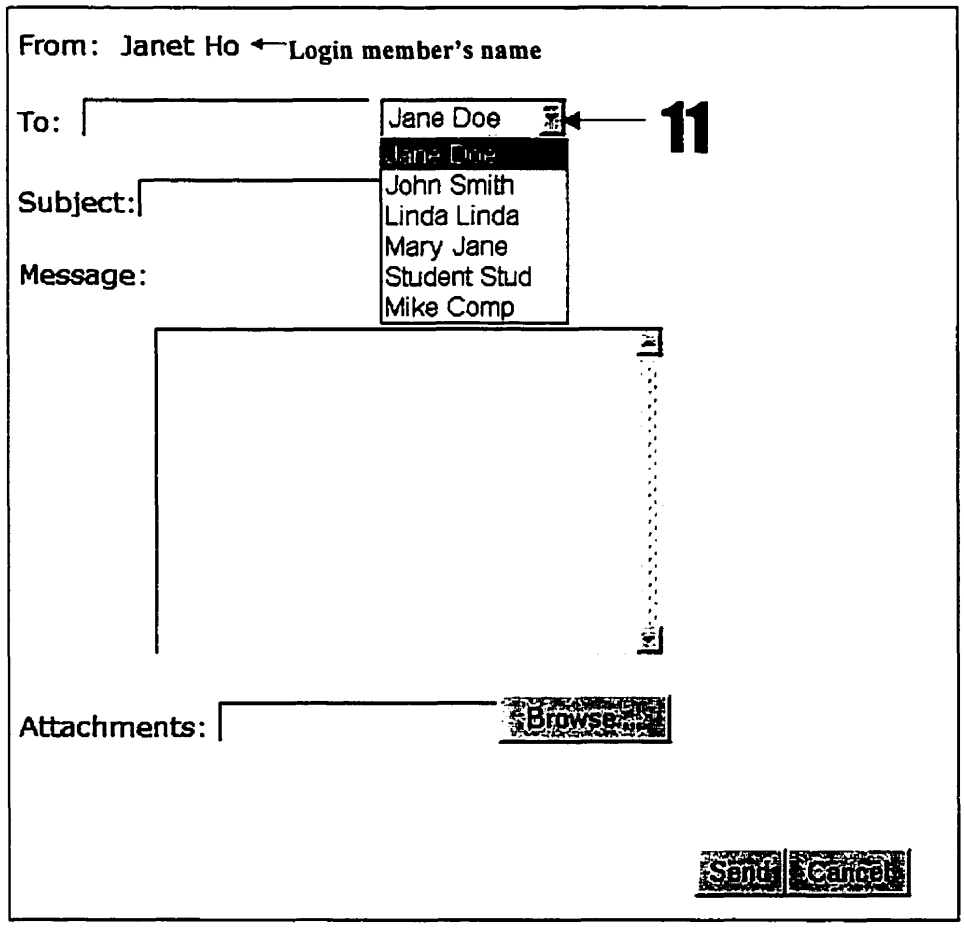

Figure 30: Group email

12. Project member list

Problem: The members did not know if other members of the same project(s) were currently using the VC, i.e. online.

Recommended change: A list of the all other members in the project groups that the member is in would be shown in a side window of the browser (Figure 31). The members are grouped alphabetically in *Online* and *Offline* categories, colour-coded (customizable) according to their

projects. This provides an opportunity for synchronous communication between members. The members can click on a name to show the person's information.

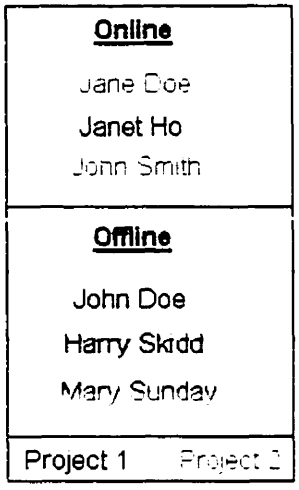

Figure 31: Project Member List

13. Adding users in *administration*

Problem: When the lab or project lead added new members, there was confusion when members had the same first and last names. The lead member could not distinguish between the members.

Recommended change: The member list shows members' first name, last name, and in addition, their login name (Figure 32). Since the system does not allow duplicated login name, the lab or project lead can identify their members through the login names.

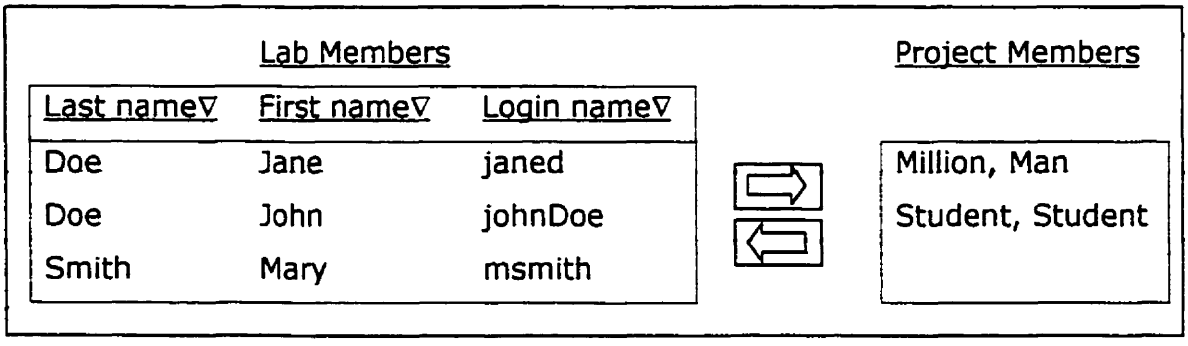

Figure 32: Adding users in *administration*

2 EVALUATION METHODOLOGY

Improvements can be made to the current evaluation methodology. Since the usage of the VC was low, the pool of participants for the user study was limited. Moreover, some members used the VC for a short period of time, which they might not have explored the full functionality of the VC. Thus, they could be recruited as the participants for the user study. Methods for recruiting participants for the user study should be explored. Since the evaluation is not for a single webpage, recruiting participants is more difficult. The participants have to get involved in the VC before they can critically evaluate it. This thesis' user study chose to use a number of graduate students as participants. However, only three out of the eight groups (of two to four students per group) chose to use the VC as the collaboration tool for their project. The number of possible candidates was thus lowered dramatically. More promotion and introduction of an incentive program are recommended for future studies. The potential participant pool should not be limited to a single class of students. There should be collaboration with other students or faculty members in the department or faculty in which group project is an important component in the course work. The recruiter has to stress the point that participating in the user study helps to build a better collaborative tool for the participants. Their names can be placed in the *Contribution* section in the VC to acknowledge them for their contribution in the development.

The current questionnaire focused on the usability of the web interface of the VC. Additional questions concerning the collaborative of the network community are required to make it more suitable to evaluate the effectiveness, efficiency, and participants' satisfaction of the virtual community. In the functionality section of the questionnaire, question 5 "I accomplished my goals in using the website" and question 6 "I was able to perform tasks and accomplish my goals on the website efficiently" concern with individual accomplishments. Rating questions for groups accomplishment should be added. For example:

1. Our group accomplished our goals in using the website. (rating choices: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)
2. Our group was able to perform tasks on the website efficiently, i.e. the website did not slow down our process. (rating choices: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree)

Rating questions of group collaboration and community are suggested. For example (rating choices: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree):

1. While using the website, I feel I am working with my group.
2. I feel it is effective to use the website to do group work.
3. It is hard for our group to communicate properly only through the site.
4. I would use this website with my other work groups.

A detail logging system is needed to properly record the usage activity in the VC. The current web server logs only provided the URL of the page visited, which was not sufficient to track the usage pattern. A separate log recording mechanism must be introduced to record parameters such as the name of the members and their usage duration on each function. However, for this type of use, policies for protecting members' privacy also needed to be developed. This logging system has to be integrated along with the development of the VC. The parameters that are useful for the studies should be passed along to the logging utility or store in a secure file where the experimenter can obtain and analyze the stored data.

The personal interviews should follow up issues raised both from the questionnaire and weblogs data analysis. The interview should be tied more closely as a walkthrough, where the participants go through their routine tasks on the BUL website with the experimenter. The participants could then describe problems as they experienced them, instead of describing them from memory.

The recommendations provided in this chapter could be used for future development of virtual communities in general. Even though the interface re-design were specific to the Bell University Labs VC; however, the problem identified in the re-design could be applied to interface designs of other virtual communities. The improved evaluation methodology could be used in evaluating virtual communities of all types that support collaborative work in different locations.

CHAPTER 6

CONCLUSIONS AND FUTURE WORK

CHAPTER 6: CONCLUSIONS AND FUTURE WORK

1 CONCLUSIONS

This thesis identified issues that are important in building a successful virtual community to effectively assist workgroup collaboration. The thesis used an evaluation framework as described in Chapter 3 to evaluate the Bell University Labs website designed for collaboration between industrial and academic partners. Results of the study showed that there is a need for improvement to both the BUL website interface and the evaluation methodology. Suggestive steps for these two areas have been provided in this thesis to improve future work.

The evaluation framework used in this study consisted of evaluation techniques for single user application evaluation. This was appropriate for evaluating the Bell University Labs website. The evaluation studies identified that VC members did not use the environment as a community, but rather used it as a place for document sharing. Bell University Labs website did not meet the criteria to be considered as a virtual community. Thus, evaluating the website as a collaborative community would not be suitable.

The study indicated low usage of the BUL site. The participants generally felt neutral about the BUL site. It is therefore reasonable to conclude they would either use other methods for work or use other collaboration software. There was almost no activity with tools in the VC other than the three most frequently accessed ones. Of these three tools, only *Document Manager* could be considered a collaboration aid. The other two tools were *About* -- the information center -- and *Administration* -- the tool for setting up new members and labs/projects. There were problems with both usability and motivation for using the BUL site. Researchers often chose alternative means of communication, e.g., face to face meetings, instead of using the BUL site.

The login duration for the VC was inconsistent: after peaking for a limited period, the login duration for each day shrank to a short period. The peak periods occurred during the initial release period. This release period applied both to the initial release of the VC itself and to the introduction of a new audience group. The first peak was during the release of the VC among the internal participating institutions; the second peak occurred when the graduate class was held. From these two periods, there was an increase in usage in the beginning, followed by a drop-off.

People visited the VC when it was new, but stopped using the VC when they found that the tool was not useful for them.

This phenomenon showed the importance of stickiness in a virtual community. In reality, going to the VC once is not enough for the survival of a virtual community. Nobody is going to converse in an empty discussion forum; nobody is going to post a document where no one else will review it. VC participants usually find the busiest place to gather. There must be activity visible to potential VC participants! Users often see the initial hype around using a new community. If a VC is not built carefully, users will lose interest. The VC must not only be built to get users to visit; it has to make the new audience continue to use the VC. The value of the VC could increase as people participate in and contribute to the community.

The cluster analysis from the study showed that users could be grouped according to their attitudes towards the VC. It was possible to identify people who determined their usability judgement on the basis of their ability to use different components of the virtual community, and those who had a more uniform attitude towards the VC. This finding suggested the idea of using personal profile characteristics as an input to personalization. Through an understanding how users rated the VC in each category (structure/navigation and presentation/functionality), customization could be built to fit an individual's need in both categories. Members could then create a preferred version of the VC.

The cluster analyses of different sections of the questionnaire differentiated between those people that responded in a similar fashion for the entire questionnaire and those people that were more discriminating in liking (or not liking) some aspects of the site but not others. This suggests that a similar method of cluster analyzing different sections of questionnaires and then rating people accordingly by their degree of discriminating judgment may be a good way of selected people to provide detailed evaluations of virtual communities, and possibly user interfaces and websites in general. The expectation is that people who are able to discriminate by responding more positively to some aspects of an artifact or a website than to others are going to provide better quality evaluative judgments.

The research findings led to the discovery of some components of the virtual community that are important for evaluation. The collaborativeness, effectiveness, efficiency and resulting user

satisfaction all affect member's preference for and commitment to the VC. The separation of the BUL website into public and private sections created two contradictory effects. When web surfers arrived at the public sections of the website, they were dismayed by its emptiness. There was so little activity in the public portion of the VC that it looked like a dormant website. However, activities were occurring behind a virtual screen. Members felt more comfortable posting documents in restricted areas. Members posted documents and events only in the private sections of the VC, which were not accessible for members outside the project group.

Not only visitors were surprised by the lack of activity in the public part of the VC, members were also concerned about the presence of their own group members. Awareness of other users can help members feel that they are not working alone. Group collaboration software exists because it provides a consistent interface for all group members. If most members of a group prefer to use other methods of collaboration, the rest of the group tends to follow. The group cannot hold a discussion forum on team issues without all group members present online. Without an indication of other group members who are using the VC, the participation rate will fall accordingly.

Finally, the thesis offered an understanding of building a successful VC infrastructure through evaluation studies. The research introduced a needs-based concept of customizing tools in the VC. The most frequently used tool in the BUL site was *document publishing*. This finding showed that most groups used only this tool even though other tools were available. If *document publishing* was the only tool a group used, *document publishing* should then be the only tool in the VC. This eliminated unnecessary navigation of going through other layers to perform the task. As the group matured and decided that more tools were helpful for collaboration, e.g., *discussion* and *calendaring*, new tools were added as needed. This was another form of personalization. The lab administrators personalized each lab's workspace according to the needs and interest of the lab members in order to fully utilize the VC for group activities.

The major findings of this thesis can be summarized as follows. The selected virtual community -- Bell University Labs website -- had usability and functionality problems, and users were not motivated to use it. Through an evaluation study, useful components and tools of the virtual community were identified. In the future, the virtual community must be evaluated through questionnaires that cover both usability and community concerns, personal interviews that

followed up issues discovered from the questionnaires, and web server logs that recorded users' usage and navigation patterns. Moreover, personal profile characteristics of users could be used to personalize the virtual community for the individual or work group. New infrastructure could then be built according to the needs discovered.

2 FUTURE WORK

The thesis identified a few questions from the recommendations and conclusions that are interesting issues to follow up after the completion of the thesis:

1. *How to get users motivated to use the VC?*
   Approximately 25 students in a graduate class were asked to use the VC as a tool for the course project; however, less than fifty percent registered at the VC. Out of those who registered, only about fifty percent actively used the VC. There was a motivation problem. It would be interesting to learn why there was a low level of interest.

2. *How to increase productive time that VC members spent at the VC?*
   The recorded login duration was low, even with the limited number of members using the VC. VC members tended to have short sessions. It would be interesting to investigate if this is the case with other VCs of the same type.

3. *How to best distinguish the separation between the public and private sections in the VC?*
   Most online collaborative websites require registration for certain regions of the site which are then "private" with other sections of the site open to the public (with or without registration). In this thesis study, the separation between public and private views of the site appeared to have a negative effect on usage because people could not see much evidence of activity (since the little activity that occurred was in private sections of the site that were not visible to others working on different projects) due the usability of this component. More study should investigate how to properly manage public and private spaces while still providing users with a sense of how much activity is actually being carried out.

In addition, after implementation of the new interface, iterative usability evaluations of the interface with modified questionnaire and interview methods would be necessary to verify the effectiveness, efficiency, and usability of the new version. With the help of the new data logging

system as recommended in Chapter 5, it would be possible to determine if members indeed used the VC regularly as a collaboration tool.

Working collaboratively over the Internet in different parts of the world is becoming common. It is necessary to reinforce the basic method of connecting: communicating effectively with others. Basic evaluation methods such as the ones used in this thesis, e.g., usability inspection and components of face to face communication, are useful to identify leads to improved methods. The evaluation methodology developed in this thesis should be tested and refined with a variety of different VCs. Only through careful evaluation will it be possible to overcome the problem of low stickiness that seemed to affect VCs, as of this writing.

REFERENCES

REFERENCES

Alwang, G. 'Instant Groupware' February 10, 1998 <http://www.zdnet.com/pcmag/features/teamware/_open.htm> (December 4, 1999).

Anderberg, M. (1973) *Cluster Analysis for applications*, New York Academic Press.

Baecker, R.M., Grudin, J., Buxton, W.A.S., Greenberg, S. (1995) 'From Customizable Systems to Intelligent Agents' In: R.M. Baecker, J. Grudin, W.A.S. Buxton, S. Greenberg (eds): *Readings in Human-Computer Interaction: Toward the Year 2000 2nd edition*, Morgan Kaufmann Publishers, Inc., p. 783-792.

Baecker, R.M., Grudin, J., Buxton, W.A.S., Greenberg, S. (1997). 'Groupware and Computer-Supported Cooperative Work' In: R.M. Baecker, J. Grudin, W.A.S. Buxton, S. Greenberg (eds): Readings in Human-Computer Interaction: Toward the Year 2000 2nd edition, Morgan Kaufmann Publishers, Inc.

Baym, N.K. (1998) 'The Emergence of On-Line Community' In Jones, S.G. (ed.) *CyberSociety: 2.0: Revisiting computer-mediated communication and community*, Sage Publications. USA: pp. 35-68.

Benyon, D. (1993), 'Accommodating Individual Differences through an Adaptive User Interface'. In Schneider-Hufschmidt, M., Kühme, T. and Malinowski, U. (eds.), Adaptive User Interfaces - Results and Prospects. Elsevier Science Publications, North-Holland, Amsterdam.

Benyon, D. R. (1993) 'Adaptive Systems: a solution to usability problems'. User Modelling and User Adapted Interaction, v. 3, n1, p.65-87.

Benyon, D., Murray, D. (1993), 'Applying user modelling to human-computer interaction design'. AI Review (6) p. 43- 69.

Blanchard, A., & Horan, T. (1998) 'Virtual Communities and Social Capital'. *Social Science Computer Review*, Vol.16, No. 3, Sage Publications Inc., p. 293-307.

Boetcher, S. 'What types of virtual communities can I build and what tools are available?' May 26, 1999 <http://www.fullcirc.com/community/communitytypes.htm> (December 4, 1999).

Brinck, T. (1998) 'Introduction to Groupware' <http://usabilityfirst.com/groupware/intro.html> (July 20, 2000).

Brown, J.R., van Dam, A., Earnshaw, R., Encarnacao, J., Guedj, R., Preece, J., Shneiderman, B., Vince, J. (1999) 'Special Report on Human-Centered Computing, Online Communities and Virtual Environments' *ACM SIGGRAPH*, Vol 33 (3).

Bruer, J. (1999) 'What's Happening' *Interactions*, Vol 6 (5), p.7-16.

Brusilovsky, P. (1996) 'Methods and techniques of adaptive hypermedia', *User Modeling and User Adapted Interaction*, v. 6, n2-3, p.87-129.

Brusilovsky, P. (1997) 'Efficient techniques for adaptive hypermedia'. In: C. Nicholas and J. Mayfield (eds.): *Intelligent hypertext: Advanced techniques for the World Wide Web. Lecture Notes in Computer Science*, Vol. 1326, Berlin: Springer-Verlag, p. 12-30.

Brusilovsky, P., Schwarz, E. (1997) 'User as Student: Towards an Adaptive Interface for Advanced Web-Based Applications' In Anthony Jameson, Cecile Paris, and Carlo Tasso

(eds.), *User modeling: Proceedings of the Sixth International Conference, UM97*, Vienna, New York: Springer Wien New York, p. 177-188.

Chignell, M & Waterworth, J (1997) 'Multimedia', in G. Salvendy (ed's), Handbook of human factors and ergonomics, 2nd ed. , John Wilely & Sons, Inc., USA, p. 1808-1861.

Dieterich, H., U.Malinowski, T. Kuhme, and M. Schneider-Hufschmidt (1993) 'State of the Art in Adaptive User Interfaces'. In: M. Scheider-Hufschmidt, T. Kuhme, U.Malinowski (eds.): Adaptive user interfaces: Principles and practice. Amsterdam: North-Holland, p.13-48.

Encarnacao, M. 'Concept and realization of intelligent user support in interactive graphics applications', July 11, 1997 <http://www.crcg.edu/Staff/mencarna/Publs/DISS/diss.html> (October 22, 1999).

Everitt, B (1993) *Cluster Analysis*, London, Hasted Press.

Garzotto, F., and Matera, M. (1997) 'A systematic method for hypermedia usability inspection' The New Review of Hypermedia and Multimedia, p.39-65.

Garzotto, F., Paolini, P. & Schwabe, D. (1993) 'HDM- A Model-based Approach to Hypertext Application Design' ACM Transactions on Information Systems, Vol. 11, No. 1, January, p. 1-26.

Guglielmo, C. 'Web Communities Can Get Sticky' July 27, 1998 <http://www.zdnet.com/intweek/print/980727/340975.html> (March 22, 2000).

Gukauf, B., Thies, S., Domik, G. (1997) 'A User-Adaptive Chart Editing System Based on User Modeling and Critiquing' *User Modeling: Proceedings of the Sixth International Conference, UM97*. Vienna, New York: Springer Wien New York.

Gutwin, C., & Greenberg, S., (2000) 'The Mechanics of Collaboration: Developing Low Cost Usability Evaluation Methods for Shared Workspaces' *Proceedings of WET ICE 2000: Evaluating Collaborative Enterprise Workshop*. Gaithersburg, MD. June.

Harasim (1993). *Global Networks: Computers and International Communication*. MIT Press, USA.

Hart, S. & Staveland, L (1988) 'Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research', in P.A. Hancock & N. Neshkati (ed's), Human Mental Workload. Elsevier, p. 139-183.

Kimball, L (1997) 'Managing Virtual Teams' Team Strategies Conference, Toronto.

Koku, E., Nazer, N., Wellman, B. (1999). 'Netting Scholars: Online and Offline' American Behavioral Scientist: Special Issue: 'Mapping Globalization 2000', Vol 43, October.

Long, B. (1999) 'Shaping Social Space from Information Space.' *Masters Thesis*. Dept. of Computer Science, University of Toronto.

Maher, M.L, Skow, B., & Cicognani, A. (1999) 'Designing the virtual campus' Design Studies, 20., p. 319-342.

Mantei and Marshall (1998) 'Introduction to Questionnaire Design' In *MIE 1403 Course Lecture Notes*, Toronto.

Marathe, J. 'Creating community online' 1999 <http://www.durlacher.com/research/resrepdetail21.asp> (March 8, 2000).

McGrath, A., (1998) 'The Forum' SIGGroup Bulletin, December, vol 19, No. 3, p21-25.

McLaughlin, M.L., Osborne, K.K., & Smith, C.B. (1995) 'Standards of Conduct on Usenet' In Jones, S.G. (ed.) *CyberSociety: Computer-Mediated Communication and Community*, Sage Publications. USA: p. 90-111.

Mehlenbacher, B., Hardin, B., Barrett, C., and Clagett, J. (1994) 'Multi-users domains and virtual campuses: Implications for computer-mediated collaboration and technical communication' DOC 94, Banff, Alberta, Canada. p. 213-219.

Morgan, C. (08/23/99) 'Virtual World for Biz Kids' <http://www.computerworld.com/home/print.nsf/all/990823bd1a> (March 22, 2000).

Mynatt, E.D., Adler, A., Ito, M., O'Day, V.L. (1997) 'Design For Network Communities' Proc. ACM CHI'97. Atlanta, GA, March, p. 210-217.

NetPlus Marketing Monthly March 1999 <http://www.netplusmarketing.com/monthly11.htm> (March 22, 2000).

Newman, W.M., and Lamming, M.G. (1995) *Interactive* System *Design*. Great Britain: Addison Wesley.

Nielsen, J. (1992) 'Finding usability problems through heuristic evaluation' in *Proc. CHI'92 Human Factors in Computing Systems*, Monterey CA, May 3-7, p. 373-80, New York: ACM/SIGCHI.

Nielsen, J. (1993) *Usability Engineering*. San Diego, CA: Academic Press.

Nielsen, J. 'Personalization is over-rated', October 4, 1998, <http://www.useit.com/alertbox/981004.html>, (November 1999).

Nielsen. J., and Molich, R. (1990) 'Heuristic evaluation of user interfaces'. Proc. ACM CHI'90. Seattle, WA, April, p. 249-256.

Not, E. And Zancanaro, M 'Content Adaptation for Audio-based Hypertexts in Physical Environments' *Proceedings of the 2nd workshop on Adaptive Hypertext and Hypermedia, HYPERTEXT'98*. Pittsburgh, USA, June.

Pinelle, D. & Gutwin, C. (2000) 'A Review of Groupware Evaluations' *Proceedings of WET ICE 2000: Evaluating Collaborative Enterprise Workshop*. Gaithersburg, MD. June.

Poltrock, S.E., and Engelbeck, G. (1997) 'Requirements for a Virtual Collocation Environment' *Proceedings for ACM GROUP 97*, Phonex Arizona, USA., p.61-70.

Rheingold, H. (1993) The Virtual Community: homesteading on the electronic frontier. Addison-Wesley Pub. USA.

Rheingold, H. (1993b). 'A Slice of Life in My Virtual Community' in Harasim, L.M. (ed.) *Global Networks: Computers and International Communication*. MIT Press, USA, p. 57-80.

Roberts, T.L. (1998) 'Are Newsgroups Virtual Communities?' ACM CHI 98 APRIL, p. 360-367.

Schiano, D.J. & White, S. (1998) 'The First Noble Truth of Cyberspace: People are people (Even when they MOO)' Proc. ACM CHI'98, Los Angeles, CA, p. 352-359.

Scholtz, J., & Downey, L 'Methods for Identifying Usability Problems with Web Sites' September 30, 1998 <http://www.itl.nist.gov/iaui/vvrg/jpaper/final.html> (December 2, 1999).

schraefel, m.c., Ho, J., Chignell, M., Milton, M., (2000) 'Building Virtual Communities for Research Collaboration' *AIWoRC'00 An International Working Conference and Industrial*

Expo on new advances and emerging trends in Next Generation Enterprises, Buffalo, NY, April.

Schrage, M. (1990) 'Shared Minds' Random House Inc., New York.

Schuler, D. (1996) *New Community Networks: Wired for change*. ACM Press, New York.

Sidhu, C.K., and Bowman, P. (1999) 'Real People in Surreal Environments' In: P.J. Sheppard and G.R. Walker (eds): Telepresence, Kluwer Academci Publishers, Netherlands, p.244-262.

Simons, J. (1997) 'Using a Semantic User Model to Filter the World Wide Web Proactively'. In Anthony Jameson, Cecile Paris, and Carlo Tasso (eds.): *User Modeling: Proceedings of the Sixth International Conference, UM97*. Vienna, New York: Springer Wien New York.

Statsoft Electronic Textbook. 'Cluster Analysis' <www.statsoftinc.com/textbook/stcluan.html> (June 24, 2000).

Steed, A.& Tromp, J., (1998) 'Experiences with the Evaluation of CVE Applications', Proceedings of Collaborative Virtual Environments, 17-19th June 1998, Manchester, UK.

Stefani, A. & Strapparava, C. (1998) 'Personalizing Access to Web Sites: The SiteIF Project' *Proceedings of the 2nd workshop on Adaptive Hypertext and Hypermedia, HYPERTEXT'98*. Pittsburgh, USA, June.

TechTarget.com 'What is ...stickiness (a definition)'. September 14, 1999. <http://www.whatis.com/stickine.htm> (March 22, 2000).

Toomey, L., Tang, JC., Mark, G., Adams, L. (1998) 'Designing Virtual Communities for Work' SIGGroup Bulletin, December, vol 19, No. 3, p6-7.

van den Berg, Guy. July 20th 1999. 'Building an Effective Web Presence' <http://www.brainwaves.co.za/Article/effective_presence.htm> (March 22, 2000).

Walls, J. (1993). 'Global Networking for Local Development: Task Focus and Relationship Focus in Cross-Cultural Communication' in Harasim, L.M. (ed.) *Global Networks: Computers and International Communication*. MIT Press, USA, p. 153-165.

Wellman, B.& Gulia, M. (1999) 'Net Surfers Don't Ride Alone: Virtual Communities As Communities'. In Peter Kollock & Marc Smith (ed.) *Communities and Cyberspace*, Routledge, New York.

Wickens, C.D. (1992) *Engineering Psychology and Human Performance, 2nd ed.*, New York: HarperCollins Publishers.

APPENDIX A

QUESTIONNAIRE

APPENDIX A: QUESTIONNAIRE

The purpose of this research is to perform a usability evaluation on the Bell University Labs website. The following questions enable us to assess your preference of the website that you have been using for your group discussion.

Background Information

Please answer the following questions by placing an X inside the box of the appropriate answer.

1. How many years have you used the Internet?

☐ Less then 1 year ☐ 1-3 years ☒ 3-5 years ☒ More than 5 years

2. How often do you typically use the Internet?

☐ More than once a day ☒ Once a day ☐ Several times a week
☒ Once or twice a week ☒ Less than once a week ☒ Never

3. How long have you used Internet chat software, newsgroup or other discussion activity on the Internet?

☒ Less then 1 year ☐ 1-3 years ☒ 3-5 years ☒ More than 5 years

4. How often do you typically use Internet chat software, newsgroup or other discussion activity on the Internet?

☐ More than once a day ☒ Once a day ☐ Several times a week
☒ Once or twice a week ☐ Less than once a week ☒ Never

Website evaluation

Please express your opinion by placing an X in the box to indicate your agreement with the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I. Structure					
1. It is easy for me to find desired items on the website:	☐	☐	☐	☐	☐
2. The organization of materials on the website is easy to understand:	☐	☐	☐	☐	☐
3. There are too many levels of nesting on the website, requiring me to drill down to items I want:	☐	☐	☐	☐	☐

4. The maps or overviews help me to locate where I am within the website:	☐	☐	☐	☐	☐
5. I am able to visualize the whole structure and layering of the website:	☐	☐	☐	☐	☐
6. The organization of materials on the website is represented consistently:	☐	☐	☐	☐	☐
7. This structure of the website and how things are organized makes sense to me:	☐	☐	☐	☐	☐
8. The information on most pages appears in a logical and natural order:	☐	☐	☐	☐	☐

II. Navigation:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The links to other pages are clearly marked:	☐	☐	☐	☐	☐
2. I can logout of (leave) the website quickly:	☐	☐	☐	☐	☐
3. There are enough links to jump to relevant area in the website without going through too many links:	☐	☐	☐	☐	☐
4. It is possible to return to bookmarked pages:	☐	☐	☐	☐	☐
5. I got disoriented at times and wasn't sure where I was in the website:	☐	☐	☐	☐	☐

III. Behaviour:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The text used on the website's pages is generally understandable:	☐	☐	☐	☐	☐
2. I am familiar with most of the functions on this website because I have used them on other websites:	☐	☐	☐	☐	☐
3. The links go to where I expect them to go:	☐	☐	☐	☐	☐

IV. User Control:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The website supports undo and redo functionality:	☐	☐	☐	☐	☐
2. I can cancel my previous action and proceed to another page:	☐	☐	☐	☐	☐

V. Presentation:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The mapping between buttons and functions is consistent throughout the website:	☐	☐	☐	☐	☐
2. The titles and headers are worded consistently throughout the website:	☐	☐	☐	☐	☐
3. There were irrelevant and extraneous materials on the website that I found distracting:	☐	☐	☐	☐	☐
4. The screen layout (e.g. button appearance, font size, font type, colour) of the website is appealing:	☐	☐	☐	☐	☐
5. More help functionality and information is needed on the website:	☐	☐	☐	☐	☐
6. The help function provided is useful:	☐	☐	☐	☐	☐
7. I can locate specific help items:	☐	☐	☐	☐	☐
8. There are unknown error without proper messaging, e.g. Javascript error:	☐	☐	☐	☐	☐
9. In the event of an error, there are helpful solutions to solve the issue:	☐	☐	☐	☐	☐

VI. Functionality:	Low	Below Average	Average	Above Average	High
1. Please rate the amount of effort you used to perform tasks in the website:	☐	☐	☐	☐	☐
2. Please rate the difficulty in performing tasks in the website:	☐	☐	☐	☐	☐
3. Please rate your level of annoyance or discouragement caused when using the website:	☐	☐	☐	☐	☐
4. Rate the amount of work spent on looking and searching for the relevant pages:	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5. I accomplished my goals in using the website:	☐	☐	☐	■	☐
6. I was able to perform tasks and accomplish my goals on the website efficiently:	☐	☐	☐	☐	☐

Thank you very much for completing the survey.

APPENDIX B

SUMMARY OF QUESTIONNAIRE DATA

APPENDIX B: SUMMARY OF QUESTIONNAIRE DATA

The following statements summarize the questionnaire data:

I. Structure

1. 7 users agree that it is easy to find items on the website (5 Neutral, 3 Disagree)
2. 10 users agree that the organization of materials on website is easy to understand (1 Strongly Disagree, 2 Disagree, 2 Neutral)
3. 7 users are neutral on whether there are too many levels of nesting (4 Agree, 3 Strongly Agree, 1 Strongly Disagree)
4. 10 users agree the map/overview help to locate where they are in the website (3 Strongly Agree, 1 Disagree, 1 Neutral)
5. 9 users agree that they are able to visualize structure of the website (1 Strongly Disagree, 2 Disagree, 3 Neutral)
6. 11 users agree that the organization of the materials is represented consistently (3 Disagree, 1 Neutral)
7. 10 users agree that the structure of the website make sense (3 Neutral, 2 Disagree)
8. 7 users agree that the information on most pages appears in logical and natural order (2 Disagree, 6 Neutral)

II. Navigation

1. 9 users agree that the links to other pages are clearly marked (3 Disagree, 3 Neutral)
2. 9 users agree that they can leave the website quickly (1 Strongly Disagree, 2 Disagree, 2 Strongly Agree, 1 Neutral)
3. 6 users agree that there are enough links to jump to relevant area without going through too many links (3 Strongly Disagree, 1 Disagree, 3 Neutral, 2 Strongly Agree)
4. 7 users reflected neutral on if it is possible to return to book marked page (3 Disagree, 4 Agree, 1 Strongly Agree)
5. 6 users agree they got disoriented at times and was not sure where they are in the website (1Strongly Disagree, 2 Disagree, 6 Neutral)

III. Behaviour

1. 13 users agree that the text used on the website's page are generally understandable (1 Disagree, 1 Strongly Agree)
2. 8 users agree that they are familiar with most of the functions on the website (1 Disagree, 5 Neutral, 1 Strongly Agree)
3. 10 users agree that the links go to where they expect them to go (1 Disagree, 3 Neutral, 1 Strongly Agree)

IV. User Control

1. 7 users disagree that the website supports undo and redo function (5 Neutral, 3 Agree)
2. 7 users are neutral whether they can cancel their previous action (5 Disagree, 2 Agree, 1 Strongly Agree)

V. Presentation

1. 11 users agree that the mapping between the buttons and functions is consistent (1 Disagree, 3 Neutral)
2. 7 users agree that the titles and headers are worded consistently (2 Disagree, 5 Neutral, 1 Strongly Agree)
3. 9 users respond neutral that there are irrelevant and extraneous materials on the website that are distracting (1 Strongly Disagree, 3 Disagree, 1 Agree, 1 Strongly Agree)
4. 5 users agree the screen layout of the website is appealing (2 Strongly Disagree, 2 Disagree, 3 Neutral, 3 Strongly Agree)
5. 6 users are neutral in if more help functionality and information is needed (2 Strongly Disagree, 5 Agree, 2 Strongly Agree)
6. 11 users are neutral to respond if the help function provided is useful (3 Strongly Disagree, 1 Agree)
7. 11 users respond neutral if they can locate specific help items (1 Strongly Disagree, 2 Agree, 1 Strongly Agree)
8. 5 users respond neutral that there are unknown error without proper messaging (2 Strongly Disagree, 4 Disagree, 1 Agree, 2 Strongly Agree)
9. 10 users are neutral as to if there are helpful solution to solve the issue in case of an error (4 Strongly Disagree, 1 Disagree)

VI. Functionality

1. 8 users feel they put above average amount of effort to perform tasks in the website (7 Average).
2. 7 users feel they have average difficulty in performing tasks in the website (4 Below Average, 4 Above Average)
3. The level of annoyance or discouragement caused when using the website is below average (6) (5 Average, 2 Above Average, 2 High)
4. The amount of work spent on looking and searching for relevant pages are above average (5) (4 Below Average, 2 Low, 2 Average, 2 High)
5. 7 users agree they are able to accomplish their goals using the website (2 Disagree, 6 Neutral)
6. 4 users agree and 5 users respond neutral if they can perform tasks and accomplish their goals on the website efficiently (2 Strongly Disagree, 4 Disagree)