Virtual Environments at Work:
ongoing use of MUDs in the Workplace

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ABSTRACT
In recent years much attention has been paid to network-based, distributed environments like text-based MUDs and MOOs for supporting collaborative work. Such environments offer a shared virtual world in which interactions can take place irrespective of the actual physical proximity or distance of interactants. Although these environments have proven successful within social, recreational and educational domains, few data have been reported concerning use of such systems in the workplace. In this paper we summarize in-depth interviews with 8 MUDders from a software research and development community where a MUD has been operational and actively used for a number of years. The interviews suggest that the MUD fills a valuable communication niche for this workgroup, being used both synchronously and asynchronously to enable the establishment of new contacts and the maintenance of existing contacts. These observations are discussed in the context of the organization under study.

Keywords
MUDs, distributed teams, collaboration, coordination, informal conversations, interviews, computer mediated communication

1 INTRODUCTION
In recent years there has been an increase in the number of distributed organizations, communities and teams [15,37]. As a result of this trend, much research is focusing on the development of technologies that support collaborative work among non-collocated individuals [38]. In this paper we consider the use of text-based MUDs or ('multi-user domains') for this purpose. We describe interview data gathered from a user community in which a MUD has been used actively for a number of years. Before detailing our study we offer a brief introduction to MUDs and MOOs.

2 MUDs and MOOs
MUDs are multi-user, end-user extensible, low bandwidth, and distributed network accessible environments [7]. In comparison to media spaces [3], video conferencing tools [13] and distributed 3-D graphical environments [5], MUDs are technologically lightweight. MUDs embody a "spatial" metaphor; activities take place within interconnected rooms wherein other users and objects are located. Text-based MUD users experience virtual rooms through textual descriptions; such descriptions contain information about objects and other users who are present in the room. This stands in contrast to visually rich MUD-related tools like The Palace (which offers a 2D graphical interface and pictorial avatar representations [30]), C2MUVE (which relies on a MOO infrastructure with VRML visualizations of MOO objects [20]) and Jupiter (which extends a basic MUD architecture with the M-Bone audio and video conferencing features and shared whiteboards [8]). Rooms within a MUD can be entered and left by using movement commands. MUDers can follow a physical space metaphor and traverse the MUD space going from one room to another, or can 'teleport' by issuing a command to go instantly to a specified room.

This spatial metaphor creates a sense of "place" or "locale" in which people feel "present" or "co-present" with others [35,39]. As with locales in the physical world, this virtual space metaphor offers a natural way to structure and organize information, and to frame activities and behaviors [2,5,16,17,21]. Further, the easy extensibility of MUDs means that end-users are able to create new locales as work and social interactions require (such as those described by Salvador and Bly [34]). The notion of activity-centered locales has been exploited elsewhere in more visual collaborative toolkits like Groupkit [14], TeamRooms [32] and Interactive's eRooms [11].

Objects and representations of MUDders (also known as "avatars") can be dynamic, having certain properties that are only apparent upon interaction. This creates a hypertextual quality to the MUD and reduces descriptive clutter. MUDs enable participants to have multiple MUD personae. This means that a single user can, if desired, be in more than one MUD room at a time, holding multiple different conversations. Given that all conversation is textual, conversation logs can be retained for later review. Therefore, unlike synchronous technologies (e.g., the telephone or desktop video conferencing) or asynchronous technologies (e.g., email), MUDs offer support for real-time interactions that can come and go over time, without requiring the constant attention of participants.

2.1 Use of MUDS

Traditionally, MUDs have supported multi-player Internet gaming (as reflected in the original meaning of 'MUD' – 'multi-user dungeon') and social chat [7,10]. Despite consideration of such environments for "serious" purposes in a recent years [40], little has been published concerning their actual and ongoing use in the work domain. Even the special issue of Computer Supported Collaborative Work (Volume 7, Nos. 1-2, 1998) focussed predominantly on the use of MUDs for networked gaming, recreational social interactions, and learning communities for children and adults [4,10,26,27,28]. Similarly, Schiano and White present data gathered about MUD interactions within a primarily social MUD environment, LambdaMOO [36]. Whilst illustrating the affordances of MUDs and MOOs for these particular usage communities, none of these papers detail the long-term use of text-based MUDs within work environments. An exception is a paper by Evard [12], which details the successful use of a MUD to support a team of co-workers. Our work extends that of Evard in presenting a more detailed commentary from the users of a MUD about the ways in which the MUD facilitates their work activities.

3 INTERVIEWS

As stated, we wish to consider the use of MUDs to support on going, medium-term collaborations in the *work place*, rather than in gaming, social or in educational settings. We believe that there are aspects of work-based collaborations that cannot be generalized from other settings, but must be established from considering specific work domains in detail. Therefore we have been studying the use of a text-based MUD within a large software research and development group. The data presented here are our initial investigations into the work practices of members of that work group who use a MUD for maintaining their communications.

3.1 The organization

Interviews were conducted with members of the Math and Computer Science Division (MCS) of Argonne National Laboratory (ANL). Like most divisions at ANL, MCS staff work on joint projects, collaborating both internally within the organization and externally with outside collaborators. Such collaborations mean that groups are fluid; they can be made up of individuals from many parts of the organization as well as from other organizations, individuals can belong to multiple groups, and groups often do not have stable membership over time, as people join and leave projects according to expertise and requirements. The primary products of projects are software, journal/book/conference papers and technical reports. Individuals' day-to-day work activities can be tightly coupled at times, including problem solving and decision making over shared artifacts like software prototypes, code and textual documents. Some activities are less tightly coupled, requiring hand-off coordination.

3.2 The MUD and the MUDders

The MUD is text-based with no shared graphical information. There are many MUD rooms. Room types are determined by the kinds of interactions that take place within them, and by who is allowed access to them. For example, personal offices are associated with particular people and may have restricted access (i.e., they may be accessible only at certain times or only to certain other MUDders), social rooms are accessible to all MUD users, and project rooms are associated with particular projects – in these, project members gather to converse about project related activities. Some rooms have textual descriptions like gaming MUDs, but project rooms tend to be sparse in description. Most people tend to "hang out" in their project rooms and/or in a "common" area or social room.

The MUD is used actively by approximately 70 self-selected individuals who are physically distributed all over the United States. For example, a number of MUDders are physically located in buildings at the main company site, some are in sister company sites, and, in the case of external collaborators, some are located around the United States in other organizations. In addition to MUDders who have accounts for work reasons, a number of their friends also have accounts in the MUD.

3.3 Interviewees

Eight interviewees were selected at random from the group of MUD users. A cross section of users was interviewed to avoid a skewed representation of MUD use. Although all of our interviewees had some computer science experience, programming skills were not deemed necessary for use of the MUD. Half of the interviewees were frequent users who program the MUD and half were casual or novice users with no interest in programming the MUD. Relevant details of those interviewed are summarized in Table 1; all names are fictitious. Interviewees agreed that there was no explicit pressure to use the MUD within the organization.

Forty-five minute interviews were scheduled with each of the eight users. Six of these interviews were held individually; two were interviewed together. Interviews were tape-recorded and took place in the interviewees' offices, by their workstations. Questions were open-ended. They included questions about how long and how much the MUD was used, what the MUD was used for, in what ways it proved useful and what frustrations there were, which spaces were used and which not used, the extent to which interviewees programmed the MUD, whether private rooms were created and used, and what aliases were used and when.

4 FINDINGS

Although not all the interviewees were entirely positive about their experiences on the MUD, all were articulate about the potential benefits for their work collaborations. It was notable that issues raised by the novice users were in accord with those of the expert users; positive comments about the affordances of the MUD were very similar, as were technical problems raised.

Name and job	MUD experience	Comments
Jerry, computer scientist	3 or 4 weeks	likes the space, uses it to coordinate with Marv
Marv, computer scientist	3 or 4 weeks	likes the space, uses it to coordinate with Jerry
Brad, systems engineer	Power MUD user	uses for broadcast messages
Rob, senior computer scientist (research)	Only used once or twice	likes email, doesn't like the cliques, hates the metaphor, can imagine uses but technology needs improving
Doris, computer scientist, systems support	Regular: programs	has multiple characters (or 'avatars') and uses for social and work purposes
Lucy, postdoctoral researcher	Regular: not expert, does not program	uses a lot for collaboration, doesn't use for social aspects
Lily, computer scientist, research project leader	Regular: meets with variety of people	uses for multiple purposes, chat and work
Bert, computer scientist, research	Only used once or twice	doesn't interact socially, worried about social aspects and has problems with the technology as it stands

Table 1: Interviewees and Their Characteristics

Given the long-term usage of the MUD, it was clear it was a successful communication medium for some members of this division. In particular, it helped many maintain their working relationships regardless of current task or location. The MUD use also supported coordination of activities, impacting use of other communication technologies and on work groupings. Finally, there were relevant technological limitations and requirements that pose problems for the users.

Our aim in this initial analysis is to consider the particulars of this situation and to gain some understanding of the social, work-related and environmental conditions for this success. Fundamental to this understanding is knowing what features of the MUD were deemed particularly useful and which features were not used at all. In the transcript excerpts that follow, speech which does not add to the point being made is indicated by '…' and, on occasion, extra context is provided in square brackets.

4.1   Maintaining relationships

The data indicate that the MUD supports relationships by enabling people to be available for each other despite being in different locations and despite being on different temporal schedules. Further, the MUD supports lightweight interactions between small and large groups.

4.1.1   Maintaining relationships across distance

Evidence from workplace studies suggests that informal communications are the "glue" for successful ongoing collaborations [37,41]. In addition, research indicates that work satisfaction and productivity in many organizations is increased within environments where social contact between collaborators is encouraged [37]. The lack of such interactions contributes to the isolation many telecommuters feel [9]. Our interviewees reported that in addition to supporting formal work contacts between separated colleagues, the MUD helps to reduce isolation for those who are distant. Indeed, the MUD was preferred to email and to the telephone as it reportedly gave a greater sense of co-presence. For example, Lucy spends some of her time telecommuting and reports the MUD to be useful for content-based collaboration.

LUCY. It's been a very nice means for us to communicate about what she's [Doris] doing, particularly when I'm not here. That was actually the motivator for me to start working on the MUD with her and we've come to use it more and more even when I'm actually here on site and it's been quite effective for us. [There follows some general discussion of use of MUD]. We do diverge and just talk about miscellaneous things, some of which are work things and some of which are not work things. And to be honest, that actually was one of the nice features for me when I was working remotely because the more familiar one gets with this kind of interaction style, the less it's noticeable to me when I'm away, my interaction is very similar when I'm away, as it is when I'm here. And in many senses that's nice. For example, if you're working on weekends or something by yourself in an office in [a distant location], you don't feel quite so isolated.

Although not explicitly mentioned here by Lucy, it is worth noting that being text-based, the MUD provides connectivity while preserving Lucy's privacy in way that video and perhaps even audio conferencing would not.

For a number of people the MUD serves as a vital information sharing and coordination tool which is used at times when they are not in the office.

BRAD: The MUD is for me a means of maintaining contact with other people in the division. A lot of the work I do involves - a lot of the work I do, I do off hours. I do from home. We have a network connection at home and so I can do much of my work remotely. What that means, obviously, is - well, what that doesn't eliminate is the need for communication and coordination with other people. For example, if I'm going to upgrade an ATM switch, which happened just this last week, what I want to do is make sure that it's not going to adversely affect other people's work and so I talk about it on the MUD and I say, "We're going to - I'm looking to upgrade this switch. It's going to have this - the new software's going to do this. Is this a good time?" And there are people who will respond, "No, it's not a good time, I have a paper due". "Ok, what about this time?" We sort of negotiate a good time and then I can come in and do it.

For this strategy to be successful, it is clear that there needs to be a critical mass of users.

The MUD supports collaborations for people who are seldom, if ever, at the central research building as illustrated by Lucy's collaborations with students who are no longer working at the main site, providing further evidence of the MUD's utility in maintaining contacts.

LUCY: So both Dan and Jim just left at the end of summer to go to graduate school. Jim has a manual that he needs to finish and hopefully he'll find the time to do that for the software that he wrote. And I've been exchanging email with him to try and - since he did not have a chance to write the manual and I didn't stay as on top of, you know, his particular coding job. I had some questions about his code so he and I have been exchanging email and MUD conversations about [it] and I'm trying to work with his code - what do I need to do. And Dan logs in occasionally just to sort of check and see how things are going because he invested a year and a half of time in this project.

4.1.2 Maintaining relationships across time

A large part of the popularity of the MUD stems from the fact that one can have synchronous and asynchronous interactions. This is clearly of import for collaborators in the same building as well as those who are physically distant. It was notable that our interviewees seemed to prefer using the MUD to using the telephone and voicemail, even though the functionality appears to be the same:

BRAD: As I see it, it fits between where you have the telephone and electronic mail. The telephone is, you know, hard synchronous. You must sort of have somebody on the other end of the phone. Email, voice mail, physical mail are all hard asynchronous. You can't communicate with somebody on the other end of the line because there's a time lag involved. The MUD is sort of intermediate because both modalities apply. I can say something to somebody whether or not they're looking, and they'll get the message. But if they are looking, we can initiate a conversation and so I think it's the synergy of the 2 modalities, which is real valuable.

Not surprisingly, this feature of the MUD also has consequences for collaborators working on different schedules and/or in different time zones.

LILY: So David is always logged in although right now he hasn't been active since yesterday. But when he does log in, if Jim has logged in in the interim, he can go to where David is on the MUD and basically leave a message for him. In the same kind of way that you do email. But then when - if they can set up a time to talk via the MUD, it's much more interactive than email and also more direct. And you can also very easily have group conversations and so we actually have a room which David and I and Ethan went to yesterday. And I was at [another geographical location] trying to get our demo ready for the symposium next week. David was [away] and Ethan was here and we were actually able to get the demonstration tested and running all via communication on the MUD. So, I mean it's actually a really handy tool that way.

Intentionally leaving messages for others is one form of asynchronous communication that the MUD affords. Another is the review of room-based conversation logs.

ROB: The best feature of the MUD is its history. [Some discussion of how to store logs follows] If I go here, I can just scroll back through things.

DORIS: … and that's fairly useful sometimes because you ask somebody what their phone number is and you can't remember that they told you it on the MUD, so you just scroll back there and find their phone number.

Such logs appear to so useful that regular MUDders stay connected to the MUD when not at work through use of locally written proxy servers, establishing what one of our interviewees called a "continuous MUD presence". By staying connected in this way, MUDders can keep their view onto activities in relevant MUD rooms even when they are not logged on and actively working. In effect, their MUD personae or avatars are present the whole time keeping a log of activities for later review, enabling collaborators to review discussions for which they are not present, or active, in the MUD. It is worth noting that only the text log of rooms which one inhabits are available – literally, you have to be there to be hearing the conversations or recording logs of them. However, the persistence of objects can be exploited to resolve this, as Brad illustrates:

BRAD: Having objects - one of the differentiations between MUDs and the sort of Internet relay chat is the ability to have persistent objects in this space. That has been more and less useful, sort of depending on the interaction. In some MUDs, for example, there are objects in the space that record a certain amount of the previous conversation so that when you get into the space you can query this object and it can report to you, say the last hundred lines of interaction, and everybody knows what the characteristics of this object are, so there's no surprises.

Use of objects as information storage sites can also contribute to the more informal interactions of group members.

BRAD: This morning, you know, on my character I'm carrying a recipe. And this morning somebody said, "Wow, that looks like a great recipe". I think I'm going to have to try it. It's for peanut butter fudge, ok. So that's an advantage.

4.1.3 Larger groups

Within the MUD multiparty conversations and broadcast messages are commonplace. These interactions were perceived to be unique to the MUD, and more efficient than using email.

BERT: And I have a need for something that has less synchronization overhead than email and that has a little bit more the multi-party aspect to it. And the MUD is the only technology we have.

DORIS: …because there are 3 of us, it helps tremendously to have us all in the same space, whereas with email [we] might not necessarily always catch people or the stuff could cross in the mail. Here it's always there, you can see the discussion going on.

BERT: … one of the things the MUD is useful for is if we have a group of people. We have a bug handling system so 2 groups I'm in are using the same tracking system with different lists. So people who just send email, it works really great. But when mail comes in, 4 people may decide to answer the mail….So if everybody was in the same room with the MUD, somebody could say, I'm going to answer that mail and then everybody would know… In many cases, you get the email, it's very easy to respond to email. It takes more time than it's worth. It feels like it takes more time to coordinate who answers the email than to actually do it. … Plus there's a lot of wasted time because everybody spends 5 minutes answering the same question or something.

The multiparty conversation support in the MUD also enables the inclusion of individuals in decision-making who, but for the MUD, would have been left out.

LUCY : ...[It would have been discussed] probably via the phone just because - and David would not have been involved. So it's mostly Ethan and I ... I could just paste [the information] in the MUD and he'd [David] get it right away as opposed to sending email which has to go off to Kansas before it can come back to [our site].

In this instance, David would not have been involved in this scenario if the MUD had not been in use. In terms of information sharing, another technology like email or video conferencing would have been equivalent. We speculate that the technological lightweightness of the MUD and its integration into the everyday activities of the individuals facilitated this situation.

Users also take part in multiple conversations in one room by using public "talk" to address everyone in the room and a private "whisper" to direct comments to one person only. Thus side conversations are possible, and due to the lack of physical cues, others in the room need not be aware of this duplicity.

LILY: ... there are multiple threads of conversation that often go on at the time and you can't have this talking over in the same way that you can in the text-based environment where you can have 2 or 3 conversations just going on.

Broadcast messages are used to inform others but also to ask questions.

DORIS: the other things that I think are particularly useful about having the room with all the people in it, you know, if I have a question about something that I'm not all that familiar with, I will ask it to the room and there may be somebody there who knows the answer that I wouldn't necessarily think of asking otherwise.

Interviewees reported that the extensibility of the MUD is exploited to create 'private' rooms for focussed discussion. This illustrates how the MUD affords the bounding of social interactions and the creation of locales for shared activities on the basis of moment-to-moment collaboration needs. This is akin to what occurs in physical world settings. Research suggests that people often regionalize communication spaces [21,34], a feature Clement and Wagner [6] call 'disarticulation'.

4.2 Lightweight conversations for coordination

We were struck by the fact that for a number of our interviewees the MUD window is a permanent feature of their everyday working set-up. Two of our interviewees, Brad and Lucy, expressed it like this:

BRAD: ... I typically have the window visible. I would say I probably look at it - and this is a rough estimate - every 10, 15 minutes, something like that. Just look to see what's happening. Obviously, if something of interest...of interest to me happens, then I get more involved in it, but it's not, you know, it's not something I check daily, it's more often than that. And it's not something I'm constantly staring at either.

LUCY: ... so basically my MUD session always lives in this corner of my computer screen and often times it's partly covered up with just enough showing that I can see if somebody wants my attention. My name will pop up. So that's what I look for. I actively communicate on it probably anywheres from 2 to 10 times a day with students or other people in the room.

Leaving the MUD window open has many consequences. One of these is the ability to use the MUD to connect with people in a lightweight way. These informal and quick interactions are used for coordinating activities with others for both social and work purposes, and have an impact on the use of other means of communication. For example, three of our interviewees stated:

MARV: we both keep a window open and we occasionally ask each other questions and, of course, the physical - the real space proximity is kind of neat because Jerry says, "I'm going over to chemistry now" and I say, I reply, I say, "Well, I'm going over to lunch, I'll stop by your office in 5 seconds". ... I'd be more inclined to say ... that we're calling each other less. If I didn't use the MUD, I would have looked up Jerry's phone number and called him.

BERT: I think even now the primary use I would see for the MUD would be the ability to do coordination quickly, faster than email.

LUCY: It's actually been really nice because Ethan works downstairs ...which is, you know, if you just have a quick question, it's much, much faster to ask me on the MUD. You know, if I'm sitting here at my computer, than to come all the way upstairs, ask me and then go back downstairs. So Ethan and I use it basically daily for that kind of communication.

A number of our interviewees noted that the MUD has enabled interaction with other members of the company that otherwise would not have taken place. This was perceived to be positive for work.

MARV: ...nice transition, brings you into contact with a lot of the division

LILY: ...I actually interact more now with some people that I never would normally have interacted with...it has expanded my horizons as far as my potential knowledge...

In physical workplace settings, such "chance encounters" have a clear impact on workplace effectiveness. Whittaker *et al.* [41] found that 92% of interactions were not pre-arranged, tended to be short and frequent. Interestingly, other technologies have concentrated on the visual aspects underlying such contacts; the support for such informal interactions has been presented as a motivating factor in the development of 3D graphical and video-based technologies [18,19,23].

As Huxor [18] points out, however, "chance" encounters do not occur entirely by chance. Social ties and physical layout can have an effect on who contacts whom and how often. Hillier [17] emphasizes the effect of work environment design (whether virtual or physical) on the establishment and maintenance of 'weak ties'. These are contacts that one normally would not make through one's central work practices. Arguably these 'weak ties' have a strong role to play within an organization's functioning. In this vein, the MUD provides a set of virtual places wherein one can "bump into" others or people can be actively sought. Our interviewees stressed the importance of such planned and unplanned encounters.

MARV:...and last night - and this are probably not a surprising anecdote to you - I wanted to contact the student who did much of the work. I said, "Gee, I bet he's on the MUD". ... so

I did a [MUD command] to see if he was on the MUD. Then I went over and said, "Do you have time?", and I interacted with him on the MUD and we had some technical discussions.

The MUD provides some awareness of the activities of others (by observing or 'lurking' in different MUD rooms). In addition, knowing where to find people in the MUD can also give one clues as to their physical whereabouts, should face-to-face follow-up be desirable:

DORIS: I've got another character called Harry, which is more of a social character, and that one hangs out in the Very Cool Hangout Room and that's sort of the large hangout space and there's a lot of people. And with that one you can sort of keep up with the group of people you can tell whether or not people are at the lab today or whether they're not.

Similarly, Sproull and Kiesler [38] point out how communication technologies change the things people pay attention to, the contacts they have and the dependencies they create. In this instance, the MUD also has changed the rhythm of work and social interactions for this group; work and social communication also occurs in the evenings, which provides a forum for social interactions between colleagues that may not otherwise be possible, and enabling the establishment of new work contacts. For example, Doris states:

DORIS: …you go, check your mail, see if anybody's awake type thing. Particularly in the evenings it tends to be far more social, and particularly very late at night. So like if you're on after 11, 12 at night and anyone else happens to be on, then - because there are not very many people waiting for them to talk to.

And later in the interview she says:

DORIS: You know, so for instance there's a lot of people who work at home – [they will] not be on-line for a while and then come back on-line and be working. And that's probably pretty much a social thing, I would think, there they are, and you may say, "Howdy, how are you doing?" And those are people that just would not - I wouldn't pick up the phone and call them. I probably wouldn't even necessarily send them email.

4.3 Barriers to MUD use
We observed a number of social and technical barriers to MUD use.

4.3.1 Social barriers to MUD use
Although the tool was clearly valued, some issues raised concerns. Interviewees commented that, being a text-based space, the MUD removes social cues gained from physical posture, gesture, voice intonation and pitch and so on. The loss of such cues can be good or bad [35,39]. Whilst it can lead to a sense of anonymity and therefore perhaps more confidence in interacting with strangers, it can also lead to problems in repairing situations which have gone awry. For instance, one of the interviewees told the following anecdote:

BRAD: I was in a fight yesterday with somebody. The other person didn't realize we were fighting. ...They were saying something that I was finding very, very hurtful. And they had no clue and there was no way for me to react in an appropriate way. … it's really hard to tell them, "Stop it, you're being" [interviewee indicates negative behaviour]. And that's really the downside because you don't get the body language

or the tones of voice. By the time you actually get through the barrier of saying, "You're causing me a problem", your tempers and emotions can run very high and get out of control quickly.

The interviewee goes on to explain that this situation required resolving by face-to-face contact. Doris and Lily also noted:

DORIS: It's difficult at times to figure out people's tone of voice when they're typing. Depending on what mood I may be in, I can interpret things, you know, it's just flat text. You can interpret things in different ways and give words different meaning and weight, which wouldn't necessarily happen face-to-face kind of situation

LILY: You have ways that you're envisioning how the person 'said' what they typed into the MUD and it may very well be that they were trying to be conciliatory and you took it as inflammatory and you respond with an inflammatory thing in your head. 'How could you say...I didn't mean that at all'. And you know, if you don't back down and realize that you perhaps didn't mean it quite that way, it can lead, I think, to a degradation of the situation that didn't necessarily have to occur. And at one time I swore never again to have a fight on the MUD because it just made it so much worse than it had to be, so yeah, that's one thing I don't do anymore.

There was also an understanding that although the impoverished cues may cause some problems, tradeoffs would also arise with other technologies:

LILY: But how do you put tone into a text-based system? A lot of people don't even necessarily want to move from a text-based system to something that has voice or pictures associated with it, it has too much real estate. Text is more fun anyway. It would be too distracting, you know, if you had voices always jabbering away, you wouldn't be able to do anything, much less - and also I mean there are multiple threads of conversation that often go on at the time and you can't have this talking over in the same way that you can in the text-based environment where you can have 2 or 3 conversations just going on.

Problems caused by lack of non-verbal cues and through violations of social protocols are not restricted to the use of MUDs and MOOs; intentional and unintentional "flaming" have been reported elsewhere [38,25]. Even within more visually rich communication media, issues of disharmony arise [1].

There are broader aspects of the perception of MUDs that go beyond the individual or group interactions. These aspects include fears of managerial perceptions, a feeling of not belonging to the in-group and a sense of professionalism. Organizational endorsement is a clear factor in the uptake of any technology [22,23,37,38]. Resistance was clear in a number of our interviewees who either were resistant themselves or feared the resistance of those they considered important.

LILY: There has been some resistance...Even though I told them repeatedly it's incredibly useful, they exchange email, 10 messages a day. I think they - I think personally they'd be better served on the MUD, but they will have nothing to do with it....I'm not exactly sure why. I think that they can sort of see that it's useful for collaboration, but the MUD is also used a lot to play and to have social interactions and I think they were turned off by that because you don't always want to see everybody else's social interactions. But now the current

situation we have, I'm still trying to convince them that it's a good idea because they can have their own separate room and just basically just talk to each other and not have to see everybody else's interactions. But they're stubborn. I'm not really sure why.

DORIS: I mean, one of the difficult things is it's hard to get people who are sort of not used to, shall we say, trying new things, to try the MUD. For instance, my adviser up at [college] who is up there a lot and I'm here most of the time, in my opinion it would be useful to be able to have some kind of space where we could interact together, but he's just very resistant to any kind of change in his work environment.

One reason for this resistance was clearly the perception that the MUD could be very cliquey and that people could feel intimidated by frequent users:

LILY: Sometimes it feels very cliquey. And I've never appreciated that kind of an atmosphere and I don't respond well to it and so basically stopped participating in it. That's all.

DORIS: ...And I think maybe that's just the resistance to...or some of them even are a little bit intimidated by sort of the groups. Sort of walking into a kind of room where you're not really quite sure how things work and you're not the expert anymore and I mean that's fairly understandable...

A number of people complained about the rich descriptions and the mapping convention utilized in this particular MUD. This was seen to be frivolous, not in keeping with the organization's image and a distraction when unnecessary text was being sent to the screen:

ROB: So for me, that stuff gets old real fast. If I want to deal with - if I want to use this to collaborate with Bert, say, then I don't want to wander from room to room and I don't want descriptions of things. I don't want anything cute. I want it to be business-like and professional and that. It probably could be configured that way, but it isn't. And it isn't an official division tool, the phone is.

And later in the interview he stated:

ROB: ...what I'm getting at is that the metaphor here is very, very rich and interesting but a 10th of 1% of it is what we want in terms of functionality. And the metaphor in which the functionality is wrapped is a barrier... It's a barrier to using the small amount of functionality that I actually want. In other words, suppose your phone was like this. Suppose in order to call someone you had to take on a persona, which then appeared on their phone. ... Just like you don't have cartoons on your letterhead. So I think there's a good project for someone to make a business MUD.

...and talking of a colleague's opinion:

ROB: ... it's this grunge he doesn't want to know anything about ...This is unprofessional goofing around.

A major cue from being physically present with others is that you know *who* they are. A number of interviewees reported having multiple characters, something that has been quoted as being one of the most appealing things of MUDs (although this is more prevalent with novice MUDders [33]). Unfortunately, in this particular MUD, in order to exploit the ability to have multiple ongoing conversations in different rooms (or to record conversations in rooms where one leaves one MUD persona), users need to have multiple characters, each with a different name.

Thus, many people talked about having multiple characters for practical purposes, but socially this is not desirable.

BERT: So that raises another problem is that I'd want to be in 2 rooms and you can do that as being different characters but I mean I carried on this conversation with Edwin while I figured out, 'Who is this guy?' And it turned out it was Rob. It's one of his aliases.

Another interviewee, Lily, made similar comments:

LILY: People use names that are different than their real names, so often you don't quite know who you're talking to which makes it more like some of the on-line social chat lines. That's actually an aspect I don't like very much ... I tend to like to view this as an extension of sort of what's going on around me and have it be based more in reality. I'm not as good at dealing with not knowing who it is I'm talking to, particularly when I work with them and interact with them on a, you know, professional level ... I haven't been so fond of strange names and descriptions that don't really allow you to know who a person is or know who you're talking to. And I do think that's kind of important in this environment where you're interacting with these people, you know, face-to-face all the time.

The spatial layout, despite the convention of using signage between rooms, has also caused problems. One interviewee reported the following:

MARV [in discussion with a more experienced MUD user]: ...he said, "Let's step off in the corner here" and said 'Jerry goes west'. So I said, 'Go west'. And what it actually did was find a room that began with the word West and dropped me all across the virtual space. It took me about 5 minutes to get back.

This is clearly also an issue of level of expertise because, unlike in physical space, *teleportation* is possible in the MUD but Marv was not aware of this.

4.3.2 Technical barriers to MUD use

A number of users reported certain issues that are to do with the implementation of this MUD. Some of these could relatively easily be remedied. The problem of having to use multiple different personae to be in multiple rooms discussed above is an instance of this. However, other issues are more consequential. One major issue was the inability to share documents effectively. For example:

JERRY: We would probably - at least I would probably visit more if I could, for example, send an equation to, say, Marv and say, "Marv, what do you think of this equation?" ...[if I want to] mouse in some text or maybe some data. Right now, if you wanted to do that, you either have to come up with some method to translate that...

MARV: I like to clip an Excel spreadsheet rather than mailing those, code or something else. I just like to clip part of an Excel spreadsheet, put it on the whiteboard and let them see it with me as we tend to keep our results in things like spreadsheets. That also applies to reports.

Doris also notes that the multi-party aspects of the MUD could be extended to enable multi-party sharing of documents:

DORIS: But that's me, it just seems really valuable. I mean, if we had the capabilities to all be - particularly for the 3 of us - all be looking at the document and be able to point at different

places, that would be really cool, but that doesn't seem to quite be there yet.

Although one can easily imagine extensions to the current implementation of the MUD, the trade-offs between extra functionality and the potential loss of lightweightness of the MUD need to be considered. Screen real-estate is also clearly an issue here; having a window or multiple windows open onto the MUD brings with it its own problems:

MARV: Yeah. I think it's the kind of tool that you should have - I'd argue you should have a window open. In fact, I - when I work from home I have an ISDN. I do a lot of things on the web. I guess I don't think of having the MUD window open but then I have a limited amount of real estate on my Think Pad.

Marv's comment illustrates that having a MUD window (or several windows) open all the time is made possible by the fact that these MUDders are networked, sit at their desks most of the time and have a large screen workstation at their disposal.

It is also apparent that the window or windows need not be attended to constantly. This, however, raises another problem, which concerns awareness of activity in the MUD. It is clearly a danger that things of relevance are being discussed in an unattended window:

DORIS: Sometimes stuff goes by and you don't necessarily notice…If somebody said something to you, you look back for your name. Yes, stuff gets missed occasionally.

A number of the interviewees offered a simple technical solution to this problem. Lily describes one possibility:

LILY: No, and in fact, you know, that's something that I think a lot of people would like is a visual bell, or a bell of some sort. Like you know the mailbox, the little flag goes up? Something like that that lets you know in fact that somebody wanted to talk to you so if you had that window closed maybe you could open it and then see what was going on. So something like that would be nice, but I don't know that that exists yet.

These issues are clearly ones that need to be resolved in the context of the work activities and the technological possibilities for particular groups.

5 DISCUSSION

Our goal is to begin to understand why the MUD worked in this instance and whether similar success can be expected in other work settings that exhibit characteristics similar to this one. We believe there are four interrelated factors that are central to success in this instance. These are (1) the communication and coordination affordances of the MUD, (2) technological and usage lightweightness of the MUD, (3) the existing work practices of the group, and (4) the organizational willingness to accept fluid and informal interactions as a legitimate part of ongoing workplace activity. These are discussed below.

Firstly, there are a number of affordances of the MUD. The MUD has communication integration, offering flexibility in allowing different ways of interacting with others, without necessitating that users shift between different tools. This flexibility supports activities along the continuum between 'loosely coupled' or coordinated, activities and 'tightly coupled' or highly interleaved, negotiated and nuanced activities. For example, the MUD supports one-on-one interactions in private and public places, one-to-many broadcast messages for information sharing or question asking, simultaneous conversations, i.e., allowing multiple conversations with people in different rooms, and multi-party communications.

The ready and easy access to the server from any machine at any place means that one can always be present and available for interaction with others. In addition, the MUD augments day-to-day interactions by enabling a persistent dimension to actions and communications. Even when not available there is a reliable place where messages can be left – message passing is aided by knowing where the author or the recipient "hangs out". The persistence that underlies this ability to leave messages also allows people to review logs; this in turn enables them to come and go over time without losing the thread of conversations and discussions. The MUD does not impose any constraints or require commitments from the users as to how long a message or text log should remain in place.

The MUD also affords the grouping of objects and people within different rooms or locales. Being multi-user, groupings of multiple participants are supported. Further, owing to the support for easy navigation between locales in the MUD environment, group boundaries and group membership are not fixed by the technology; changing group organizations are easily supported. The MUD's extensibility also means that new locales can be easily created as needs dictate. These features stand in contrast to many other communication technologies which do not support such easy transitions. In addition to active contacts with others, the MUD also provides an awareness of the availability of others, and of their activities.

These MUDders also exploit other affordances of the technology. Dynamic objects are created which "contain" information for others and are carried from locale to locale. Using simple commands, such objects can also be left in specific locales for others.

Secondly, the MUD is technically and socially undemanding, or "lightweight". It has a certain lack of "self-centeredness"; that is, it does not impose a significant overhead for set up or for maintaining ongoing interactions and, thus, is not itself the focus of the MUDders' cognitive work. The MUD is also less demanding than other technologies like the telephone [31] and less personally intrusive than video conferencing. We feel these factors contribute significantly to the MUD window being permanently 'up' on many people's screens. This in turn helps to create and maintain a persistent MUD presence, and a willingness on the part of users to explore ways the MUD could be used. The MUD also takes up less screen real estate than many visually oriented, place-based tools that require multiple windows or visually rich applets within web pages.

Thirdly, the work practices of the group are in accord with the technological requirements and the affordances that the MUD offers. Much work takes place in conversations where colleagues share information and problem solve together. Conversations are also central to coordinating loosely coupled collaborations. In terms of technological support, the collaborators are networked already; most ongoing work takes place at personal workstations where large screens are available, and machine memory and cycles are not an issue. In these ways the work practices of the group and the network infrastructure are a good match for the use of a tool like a MUD.

Finally, the organization itself is one in which informal, interpersonal contacts are readily accepted. Not all organizations encourage such contacts [22, 37].

Aspects of the MUD that were not valued in this group were precisely those that are of relevance to the activity of gaming: anonymity, multiple personae and rich textual descriptions. These, it was felt, interfered with interactions.

6 CONCLUSIONS AND SUMMARY

The interview comments suggest that the MUD has become a significant part of the working environment for many members of this organization. Novice and experienced interviewees, both in their practices and comments, demonstrated that the MUD offers some communicative support that has not been available from conventional technologies such as the telephone, video teleconferencing and email. Specifically the MUD:

1. Enables the maintenance of existing relationships, irrespective of distance or time. It has the potential for the establishment of new relationships, expanding the social networks within the work environment.
2. Enables the coordination of activities within large, dispersed groups.
3. Reduces the time taken for certain interactions, especially quick coordination interactions which would take longer by email or if one sought out colleagues physically.

In sum, the MUD centralizes the social processes that are foundational to establishing the common ground that is needed for maintaining on going collaborations. This is achieved without forcing users to engage in one type of interaction (for example synchronous or asynchronous). The ongoing use of this simple text-based MUD illustrates that rich visual and auditory connections are not central to collaborations within this organization; fluid, informal conversations and the social relationships they support are.

Our findings suggest that further study is warranted to understand and frame the use of these lightweight, virtual environment technologies, in this and in similar organizations. Our intention is to provide characterizations of these and other technologies which address the interplay of the four factors we identified within this study. These factors are: (1) the communication and coordination affordances of MUDS, MOOS and similar technologies; (2) the technological lightweightness (or not) in terms set-up and maintenance characteristics of these and similar technologies; (3) the working practices of the group(s) involved (including availability of and reliance on computer-based communication networks); (4) and the organizational context.

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