Collaborative Virtual Environments - Hype or Hope for CSCW?

Hannes Olivier; Niels Pinkwart

Department of Informatics
Clausthal University of Technology

Collaborative Virtual Environments - Hype or Hope for CSCW?

Hannes Olivier; Niels Pinkwart

Institut für Informatik TU Clausthal Julius-Albert-Str. 4 38678 Clausthal-Zellerfeld
hannes.olivier@tu-clausthal.de niels.pinkwart@tu-clausthal.de

Abstract

Due to recent technology advancements, collaborative virtual environments (CVEs) where users can interact and collaborate via avatars in 3D worlds have become more and more common in home and professional usage. This paper discusses these newly upcoming tools from a CSCW perspective. We show that current CVEs can be seen as integrated environments that serve many (though not all) of the functions of traditional CSCW systems. In particular, a review of recent empirical studies with CVEs shows that these tools are beneficial with respect to some critical factors of CSCW: interactivity, private self-awareness, and social bonds between users. Based on these findings, this paper proposes a research agenda to further investigate the question in how far the newly emerging 3D CVEs have potential as CSCW tools.

1   Introduction

The World Wide Web has been constantly growing and changing since its creation in the early 1970s - and it will probably continue to do so with ongoing hard- and software advances. If one wants to divide the steady development in different stages, then the first stage is usually called "Web 1.0" nowadays. In this first generation, the Web primarily served as a static way of providing and retrieving information (though it was originally planned as a much more interactive and dynamic structure). Servers contained and delivered this information to the users who consumed it. In the late 1990s, a change slowly began. The resources in the Web became more and more dynamic, as evidenced by the idea of forums and wikis which exceeded the possibilities of the first stage. This "Web 2.0" can be characterized through an "exploitation of the long tail" - end users get actively involved, can expand the Web and contribute their resources and ideas. In the "Web 2.0", communication and information exchange between users became more and more important: the classical hierarchical information delivery was no longer the sole purpose of the Web.
This fact contributed to the name "Social Software" for Web 2.0 applications. Services such as cnn.com for instance allow the user to decide which news he wants to have on

his screen and one of the options is to generate his own news feeds. Other sites like ebay.com or amazon.com rely on the user and his activities as an essential part of their system (through feedback, ratings and reviews). Further, applications like del.icio.us or flickr.com exist for the primary purpose of allowing users to share resources - in these cases, bookmarks and photos.

Although "Social Software" is still a term that stands for an emerging technology, these "Web 2.0" applications have gained considerable user communities nowadays. At the same time, the term "Web 3.0" has already been proposed to characterize yet other upcoming sorts of the Web. Some groups consider the Semantic Web [**?**] as the main new technology - although one might well argue that the "killer application" for the Semantic Web has still not been shown. Others propose collaborative virtual realities (CVEs) like Second Life (SL) or "Croquet" [Smith et al., 2003] as the most important advancement of the Web, justifying a new "version number". These digital media are not only at least as interactive and cooperative as the "Web 2.0" tools, but offer integrated 3D virtual worlds with avatars (and thus representations of passive participants). This advances past the old 2D environments [Moore et al., 2007]. From a pure technology viewpoint, 3D CVEs are not new. In fact, the scientific community has researched technologies for virtual 3D environments for quite some time. But the public acceptance and usage of these tools has risen considerably only recently, probably due to technology advances that now enable also the end user - the "long tail of the Web" - to access and use CVEs with standard computers and networks from their homes and offices. So, collaborative virtual environments might currently have their tipping point from few specialist users to massive distribution and usage. The potential of these "Web 3.0" virtual worlds has not been fully explored or discussed in the research community yet. Some downgrade these new environments as "games" without relevance for serious application areas. But there are indeed some interesting findings about the advantages of 3D CVEs in CSCW applications. The remainder of this paper reviews these and - on a more general level - discusses the value of CVEs as CSCW tools. We first give an overview on current technologies and the major application areas for CVEs. Then, we discuss collaborative virtual environments in the light of the "classical" CSCW tool typology and review relevant empirical findings. Based on all this, this paper proposes a research agenda for the investigation whether CVEs really have the potential for a new "version number" of the Web - at least from a CSCW perspective.

2 Collaborative Virtual Environments - Usage and Technology

As stated in the introduction, the idea of using CVEs (e.g., for work and education applications) is actually not that new. There have been quite a number of developments concerning these environments in the past decade. But most of these were focused on solving technical issues with designing and building a CVE (e.g.[Benford et al., 1994, Oliviera et al., 2000]). Currently, technological development has advanced beyond these

early stages. Both commercial and freely available CVEs exist today. These usually have a platform character where digital representations of the users (normally called avatars) can interact. In most cases, these avatars are a human like figure. Currently, CVEs are used already in a variety of different fields: gaming, business, education, social communication, and cooperative development.

As of today, the by far most famous application area for 3D CVEs is *gaming*. Even older games like Doom[1] (1994) can be seen as an early CVE. So-called MMORPGs (Massive Multiplayer Online Roleplaying Games) like World of Warcraft[2] today draw millions of players to play together in virtual worlds. While cooperation is possible but not needed in some (especially older) games, newer games often present situations where players have to cooperate to succeed. World of Warcraft is a paradigm example for this. It has millions of users in different countries and easily broke all records of sold computer games. Among other reasons, the collaborative and social aspects of the game and in particular its longer-term player associations (guilds) surely contributed in a major way to this [Ducheneaut et al., 2006].

A number of companies have recently stated using CVEs - in particular the prominent Second Life[3] - for *business* purposes. Major advantages in sales through this new medium as compared to traditional 2D Web shops have not be reported yet, but it is at least interesting to notice how many companies from different fields as varied as Adidas, Sun Microsystems, and Toyota (and many more) were early adopters of this technology and use it to promote their products and to ensure their brands are getting exposure amid the consumers.

Another major field of study and application for CVEs is *education*. Second Life alone triggered quite a number of studies about the use of virtual campuses [Livingston and Kemp, 2006, Livingston and Kemp, 2007]. A considerable number of colleges and educational researchers have already used this versatile platform to give online lectures and to investigate the pedagogical usefulness of this novel medium. One other example for an educationally targeted CVE is MOVE, which was designed for training in the medical field [Garcia, 2002].

Also for the purposes of *creativity and social communication*, CVEs have become more and more popular. These environments have not been created for a specific use besides offering people a way to express their creativity and to enjoy virtual company and interactions with users from all over the world. One major representative for this environment type is Second Life. It was developed by Linden Lab and got a lot of press coverage in the last year. Some articles presented it as a kind of multifunctional wonder of the world of tomorrow [4] Up to today, more than 9 million users registered for SL accounts, and the number of accounts is growing fast. In the last couple of months, the press coverage turned more and more into the negative, but this did not stop people from experimenting with this apparently exciting platform. This year's Second Life

---

[1] Id Software: http://www.idsoftware.com/games/doom/doom-gba/

[2] Blizzard: http://www.wow-europe.com/de/index.xml

[3] Linden Lab: http://secondlife.com

[4] http://money.cnn.com/2006/11/09/technology/fastforward_secondlife.fortune/index.htm

Convention, the third to be held, was attended by several hundreds of people meeting both in real life Chicago and "in-world" (= inside the platform) to discuss topics of business, education, art and entertainment in Second Life. One reason Second Life gets thousands of people to be online at the same time is that the users can be creative in creating and developing the virtual world together. Still one of the major uses of Second Life is for socializing. Users communicate via the different channels (IM/chat, "email"/notecards, Voice over IP) and share their created content.

Finally, also in the area of cooperative work and development, CVEs have already been used (though not a lot). Companies started to use CVEs as virtual meeting rooms with shared whiteboards. This was supposed to replace the need for physical meetings and as an alternative to video or phone conferencing. One example of such a software is Workspace 3D[5]. Another CVE platform for collaborative development called Croquet[6] with high potential is currently under development. It is still in an early version and mostly used for research purposes. The aim of Croquet is not only to allow people to communicate with another but to enable them to co-construct artifacts in this environment, going beyond the development of in-world exclusive content. One simple example is, that avatars can edit texts or even edit their blog in the "regular" internet.

3 CVEs in the CSCW taxonomy

After the previous review of current CVEs and their application areas, this section discusses the role and position of CVE tools in the classical CSCW tool categories on a more general level. As a basis for this discussion, we employ the traditional groupware tool functions as contained in [Dix et al., 2004]: computer mediated communication, meeting and decision support, and shared applications and artifacts.

With respect to the first (*computer mediated communication*), CVEs usually emulate co-locatedness in a synchronous setting with remote users by representing the users through avatars. Even if the users may be at different locations, their avatars can be made co-located easily and thus make use of traditional co-located communication means such as gestures. The popular platforms include a lot of communication methods that enable the users to communicate with each other through their avatars. One example is shown in the Second Life screenshot below. The bottom left shows the local communication history. The bottom right shows Instant Messages between people and inside groups. The top right has a group notice to be send to all members (on- and offline). The middle message shows a notecard, which is something similar to an email. Second Life also includes the option of speech messages via Voice over IP. This add-on not only allows a worldwide group chat, but in an alternate mode it also considers the source of the voice in the 3D sound model. For example, coming closer to the sound location or looking at it will increase the volume of the sound.

What is missing in most CVE platforms is the option of structured asynchronous communication. Table 1 summarizes the strengths and weaknesses of 3D CVEs as

---

[5]Tixeo Soft:`http://www.workspace3d.com`
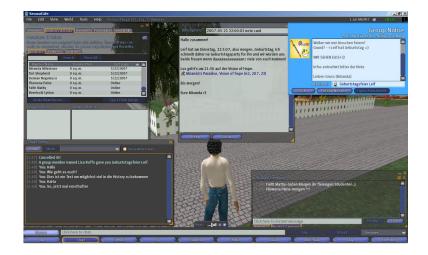[6]Croquet Consortium: `http://www.opencroquet.org/index.php/Main_Page`

Figure 1: Communication options in Second Life

	Synchronous	Asynchronous
co-located	No specific support: CVEs try to generate co-locatedness	No specific support: CVEs try to generate co-locatedness
remote	very good and flexible support	usually good support only for unstructured communication

Table 1: CVEs for Computer Mediated Communication

communication tools in the classical time/space matrix. When it comes to the second traditional function of CSCW tools, *meeting and decision support*, the options of the different platforms differ greatly. Some offer helpful tools such as group structures with definable roles and voting systems, and in most of the environments virtual meeting rooms are available or can be generated easily. Classical argumentation software or discussion support tools have not been included in the widely used CVEs, however.

Most CVEs excel in the function of providing users access to *shared artifacts*. They easily allow different users to modify objects (and sometimes scripts/texts) of other users. This is sometimes regulated by owner and group rights. Some of the environments - like the Croquet system discussed in the previous section - have actually been designed for the primary purpose of helping users to co-construct digital artifacts.

A cross-cutting theme in CSCW - apart from the three major tool functions listed above - is awareness. Helping users to "know what is going on in the system" is a necessity for the success of groupware [Gutwin and Greenburg, 2002], and it is therefore not

surprising that the successful and widely used CVEs provide a variety of awareness functions. Users can find out where their co-workers are located (via search options) and what they are currently doing (e.g. typing postures/sounds for talking activity). As this section shows, it is difficult to embed CVEs into the traditional taxonomy of CSCW tool function. CVEs are communication tools which offer shared artifacts and can also be used for meeting support. While today's CVEs may excel at some of these topics more than at others (e.g., strengths in synchronous communication vs. lack of features for asynchronous discussion support), they still integrate many aspects of other CSCW software in one product.

4   Three arguments for using CVEs as CSCW tools

So why should one use "general-purpose" CVEs for collaborative work and not the existing established tools that often provide similar (and more specific, task-oriented) functions? Recent empirical studies provide three arguments: the use of CVEs can improve the private self-awareness of users, the social bonds between them, and the interaction options of users within the system. All these factors are supportive to cooperative work.

Customizable human avatars are available in almost all CVEs. Research indicates that users who customize their avatar build a stronger relationship with it, which then results in an increased *private self-awareness* [Vasalou et al., 2007]. When privately self-aware, one is able to reflect more on one's attitudes, standards [Fenigstein et al., 1975] and emotional states [Scheier, 1976]. This is helpful for some group work activities.

While text-based communication does offer some options to convey human emotions, it is still much more difficult and less substantial than facial expressions [Gutwin and Greenburg, 2007]. Humans react to the visual input of a face in communications, even when it is only a rough avatar representation [Yee et al., 2007]. Avatars do not present the same amount of awareness clues than a real person, but they do often offer some common human gestures. Studies have shown that enriching them with embodied information can still be processed by the human with little difficulty and reduce still existing coordination problems [Moore et al., 2007, Stach et al., 2007]. As such, avatars in CVEs can contribute to CSCW by *improving the interaction* (especially the coordination) between users.

The third - and probably most important - argument for CVEs as CSCW tools is that they have to potential to *increase social bonds* between users. An example: In older and frequently visited 3D worlds, users already have created recreational areas to spent time at and relax. In some areas of Second Life musicians sometimes even offer virtual concerts. One example of a virtual bar can be seen in figure 2.

While this is not directly improving the work, it allows to a certain extent that members of a group can spend time together besides work. This allows something comparable to a "virtual beer" after work. These "soft" social bonds in distributed cooperation have serious implications for work: with more and more projects being worked on in a distributed manner, the need for supporting software becomes more

Figure 2: A bar in Second Life with a Live Band playing. Copyright 2007, Linden Research, Inc. All Rights Reserved.

and more important. While the results of collocated and distance groups with digital communication might be similar, computer based discussions lead to less satisfaction and a smaller knowledge base [Thompson and Coovert, 2003], and also the productivity does differ significantly for some tasks [SM94]. Companies have known for some time that a good cooperation does not only need technical support and worker expertise, but also social bonds like trust: these bonds can help to improve productivity [Kr99]. Using text based communication, trust cannot be not developed as fast and strong as in face-to-face meetings [Cunnings et al., 2002], [Bos et al.,]. Studies in the e-learning community show that face-to-face meetings at the beginning of a program helps to build the necessary bonds which are continued with online communication [Haymonthwaite et al., 2000]. Other studies show that Video Conferencing and Voice-over-IP help to build trust [Bos et al.,], although there seems to be problems when the tools are used between collocated groups. Using the communication-rich game "Mafia", Batcheller et al. showed that Video conferences conveyed the same satisfaction level as a purely collocated game [Batcheller, 2007]. Nguyen and Canny presented

a problem with spatial faithfulness in video conferences with collocated groups. They presented a design which improved the trust level of users to a level that was on par with face-to-face meetings [Nguyen and Canny, 2007]. In summary, social bonds are evidenced as a determinant of productivity and confidence. Social bonds, however, are built easier between collocated persons than between remotely collaborating persons. It is very plausible that 3D CVEs with their increasing effect on private self-awareness have the potential to allow users to engage in more intimate, meaningful conversations that increase social bonds in the group [VJP07] and thereby contribute to confidence and productivity.

5   A Research Agenda

While some arguments can be made that CVEs are not only an emerging technology that is probably at the tipping point towards wide distribution and mass usage but may also play a major role in tomorrow's CSCW, there are still a number of central questions open. These are summarized in the following.

Workplace Adoption: At the moment, most people using CVEs are quite adapt in the use of software and computers. But are they intuitive enough so that also inexperienced people can learn their usage quickly, too - and is their perceived benefit high enough to make users want to learn them? Given the availability (and established usage) of other tools that "can do the same", would people - especially decision makers - be willing to switch to CVEs? To answer these critical questions about workplace adoption, a lot depends on how easy and useful do people perceive the CVEs.

Success Factors: Some of the research reviewed in this paper promises that CVEs have great potential as a CSCW tool by improving in particular (but not only) the social bonds. However, extensive empirical research still needs to be undertaken to gain further insight into how CVEs compare to other conditions like co-located work, video conferencing or text/speech based communication in terms of results and productivity. Can any success of CVEs be attributed to the increased interactions, positive self-awareness and social bonds (trust), or are there other yet undiscovered factors?

Design Elements: While it seems that CVEs can help to improve productivity in CSCW settings, the design factors - the "building blocks" - that lead to the effect are not explored in depth yet. Which elements of avatars (and the rest of the 3D world) make the difference in terms on increasing social bonds? Can the effect be strengthened through further mechanisms? Some emotional information normally given by body language can with a little training be conveyed by text or sound. While the avatars give only reduced body language information, they might be improved with other awareness clues a human body does not offer. Would such an enrichment of avatars (e.g. by adding video elements or further information bits) have positive effects on group work?

6 Conclusion and Outlook

This paper provided a conceptual view on the role of the currently emerging collaborative virtual 3D environments for Computer Supported Cooperative Work. A categorization of modern CVEs within the traditional CSCW tool functions yields that the virtual environments are rather multi-purpose, serving a range of functions from communication support to the provision of shared artifacts. We discussed three arguments why the use of an integrated CVE instead of several more specialized "traditional" CSCW tools can make sense: increasing user's private self-awareness, improving the social bonds between them, and facilitating interaction (especially coordination). Based on these findings, we believe that CVEs indeed have a great potential as CSCW tools. Yet, some research is still needed to fully understand the strengths and weaknesses of avatars in 3D worlds in CSCW settings. In our own research, we will focus on the relation between social bonds and productivity in group work. We will use test groups to see if productivity and results differ if groups use face-to-face, video conferencing or other communication techniques in comparison to virtual worlds.

References

[Batcheller, 2007] Batcheller, A. (2007). Testing the technology: Playing games with videoconferencing. *CHI 2007 Proceedings*, pages 849–852.

[Benford et al., 1994] Benford, S., Bowers, J., Fahlen, L., and Greenhalg, C. (1994). Managing mutual awareness in collaorative virtual envroments. *Proceedings VRST 1994*.

[Bos et al.,] Bos, N., Olson, J., Gergle, D., Olson, G., and Wright, Z. Effects of four computer-mediated communications channels on trust development. *CHI 2002*, 4:135–140.

[Cunnings et al., 2002] Cunnings, J., Butler, B., and Kraut, R. (2002). The quality of online social relationships. *Communications of the ACM*, 45:103–108.

[Dix et al., 2004] Dix, A., Finlay, J., Abowd, G., and Beale, R. (2004). *Human Computer Interaction*. Prentice Hall, third edition.

[Ducheneaut et al., 2006] Ducheneaut, N., Yee, N., Nickell, E., and Moore, R. (2006). Alone together? exploring the social dynamics of massively multiplayer games. *In conference proceedings on human factors in computing systems CHI 2006*, pages 407–416.

[Fenigstein et al., 1975] Fenigstein, A., Scheier, M. F., and Buss, A. H. (1975). Public and private selfconsciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology*, 43:522–527.

[Garcia, 2002] Garcia, P. (2002). Move: Component groupware foundations for collaborative virtual environments. *Proceedings on the 4th International Conference on Collaborative Virtual Enviroments*, pages 55–62.

[Gutwin and Greenburg, 2002] Gutwin, C. and Greenburg, S. (2002). A descriptive framework of workspace awareness for real-time groupware. *Computer Supported Cooperative Work*, 11:441–446.

[Gutwin and Greenburg, 2007] Gutwin, C. and Greenburg, S. (2007). Expressing emotion in text-based communication. *CHI 2007 Proceedings*, pages 929–932.

[Haymonthwaite et al., 2000] Haymonthwaite, C., Kazmer, M., Roins, J., and Shoemaker, S. (2000). Community development among distance learners: Temporal and technologial dimensions. *Journal of Computer Mediated Communication*.

[Livingston and Kemp, 2006] Livingston, D. and Kemp, J., editors (2006). *Proceedings of the Second Life Education Workshop at the Second Life Community Convention*.

[Livingston and Kemp, 2007] Livingston, D. and Kemp, J., editors (2007). *Proceedings of the Second Life Education Workshop at the Second Life Community Convention; To be published*.

[Moore et al., 2007] Moore, R., Gathman, E., N.Ducheneaut, and Nickell, E. (2007). Coordinating joint activity in avatar-mediated interaction. *CHI 2007 Proceedings*, pages 21–30.

[Nguyen and Canny, 2007] Nguyen, D. and Canny, J. (2007). Multiview. improving trust in group conferencing through spatial faithfulness. *CHI 2007 Proceedings*, pages 1465–1474.

[Oliviera et al., 2000] Oliviera, J., Shen, X., and Georganas, N. (2000). Collaborative virtual environment for industrial trining and e-commerce. *IEEE VRTS*.

[Scheier, 1976] Scheier, M. F. (1976). Self-awareness, selfconsciousness, and angry aggression. *Journal of Personality*, 44:627–644.

[Smith et al., 2003] Smith, D. A., Kay, A. C., Raab, A., and Reed, D. P. (2003). Croquet Ű a collaboration system architecture. *Proceedings of the Conference on Creating, Connecting and Collaborating through Computing (C5)*, 79:2–9.

[Stach et al., 2007] Stach, T., Gutwin, C., D.Pinelle, and Irani, P. (2007). Imporving recognition and characterization in groupware with rich embodiments. *CHI 2007 Proceedings*, pages 10–20.

[Thompson and Coovert, 2003] Thompson, L. F. and Coovert, M. D. (2003). The effect of computer conferencing on perceived confusion, satisfaction, and postdiscussion accuracy. *Group Dynamics: Theory, Research, and Practise 2003*, 7:135–151.

[Vasalou et al., 2007] Vasalou, A., Joinson, A. N., and Pitt, J. (2007). Construction my online self: Avatars that increase self-focused attention. *CHI 2007 Proceedings*, 7:445–448.

[Yee et al., 2007] Yee, N., Bailenson, J. N., and Rickertson, K. (2007). A meta-analysis of the impact of the incluson and realism of human-like faces on user experiences in interfaces. *CHI 2007 Proceedings*, pages 1–10.