Virtual Worlds as Innovative Collaboration Media for Distributed Work

# Abstract

Despite the growing prevalence of distributed work as an organizational form, the virtual world literature has largely neglected to consider the potentials of this new media in distributed collaboration. In the present study, we addressed this gap by first reviewing the virtual world literature on enablers and forms of potentially innovative collaboration and then comparing that knowledge to interview results of 47 persons who use virtual worlds in their distributed work. This comparison revealed many innovative collaboration potentials of virtual worlds in distributed work. Most findings or suggestions on the benefits of virtual worlds mentioned in literature were confirmed by our interviewees. Immersion, engagement, social presence, use of avatars, and import of 3D objects were seen to enable innovative collaboration also in distributed work settings. These enablers, in turn, were noted to promote such widely discussed forms of innovative collaboration as co-creation and training. The most interesting additions to literature found in the interviews of distributed workers were: questioning the importance of avatar modification, the notion of storing information to virtual worlds, potential for asynchronous co-creation, and knowledge sharing. Moreover, such collaboration uses that have been relatively little discussed in virtual world literature as organizing small meetings and large events were perceived to be important in interviews. These additions arise from the nature of distributed work: business context, need to store and share knowledge over geographical boundaries, working across time-zones, and the burdens and costs of traveling to remote sites. In sum, our results indicate that virtual worlds provide many opportunities to become innovative collaboration media for distributed work.

# Introduction

During the last two decades the global reach of organizations has grown to encompass the whole world. Globalization of businesses, the need to recruit experts from all over the world near customers, and requirements to cut travel costs have made distributed work the *de facto* mode of work for many organizations (Gibson & Gibbs, 2006). In distributed work people collaborate remotely with their colleagues, either while traveling, from home, from another office, or from a customer’s site. The essential features of all distributed work are that employees are mainly dependent on computer-mediated communication (CMC) and that they work over geographical boundaries in order to achieve a common goal (O’Leary & Cummings, 2007). Research on distributed work often discusses the impact of crossing geographical boundaries in terms of collaboration, culture, and team dynamics (Armstrong & Cole, 2002; Hertel, Geister, & Konradt, 2005; Martins, Gilson, & Maynard, 2004; Maznevski & Chudoba, 2000). Furthermore, a vast amount of literature has discussed different types of communication technologies and their impact on distributed work (e.g., Majchrzak, Rice, Malhotra, King, & Ba 2000; Townsend, DeMarie, & Hendrickson, 1998).

Over time, technological development has created a multitude of CMC technologies for distributed collaboration ranging from improvements in mobile technologies to virtual worlds (VWs). The pros, cons and effects of more conventional technologies for distributed work have been studied to some extent and the results are somewhat mixed (see Axtell, Fleck, & Turner, 2004 for a review). Some studies suggest that computer-mediated tools filter our essential social cues in distributed collaboration (e.g., Sproull & Kiesler, 1986), whereas others argue that people are very adaptive and that mediated collaboration may, for example, shift the attention from ethnic differences and hence be beneficial for globally distributed teams (e.g., Lea & Spears, 1991). However, none of these studies has considered the use of VWs. Therefore, in this paper we primarily focus on professional 3D virtual worlds that are used for distributed work. 3D VWs are communication systems in which multiple interactants share the same three-dimensional digital space despite occupying remote physical locations and can navigate, manipulate objects, and interact with one another, usually via avatars (Yee & Bailenson, 2007). Avatars are flexible and easily transformed digital self-representations in a graphic 3D form. By professional VWs we mean such applications that are targeted to or can be used in work rather that just in socializing or gaming. Such VWs have gained some popularity during the past decade (e.g., Gillath, McCall, Shaver, & Blascovich, 2008). However, most of the current discussions in VW literature have not explicitly underlined the media’s usefulness for distributed work. Still, the notion of VWs’ ability to get their users involved to many kinds of activities over geographical boundaries is clearly embedded in much of the reasoning in VW literature (e.g., Pollit, 2007; Reeves & Read, 2009). A large amount of VW literature has a strong focus on technology, but few studies directly approach the question on how this new technology might be applicable for distributed work (Sivunen & Hakonen, 2011; for exceptions see Davis et al., 2009; Lantz, 2001). This article addresses this gap and studies the intuitively appealing idea that many VWs have vast potential to be collaboration media for distributed work. The difficulties presented in earlier research on distributed work like the crossing of geographical boundaries, lack of face-to-face contact, difficulties in trust and engagement (Armstrong & Cole, 2002; Hertel et al., 2005; Martins et al., 2004) might be overcome by VWs. Since VWs provide a platform for synchronous interaction and are used over broadband from multiple geographical locations, we argue that they have a potential to be a collaboration media especially for distributed work. Moreover, the use of VWs for distributed work involves potentially new or improved technology-mediated ways of collaboration. Hence, we define *innovative collaboration* not in terms of innovation research but simply as new or improved ways of collaboration. The scope of this article is on innovative collaboration in relation to distributed work when VWs are used as collaboration tool or media.

In VW literature it is often suggested that collaboration in VWs is affected or is unique due to psychological processes or attitudes such as immersion or engagement (e.g., Helms, Giovacchini, Teigland, & Kohler, 2010) which, in turn, are suggested to be stronger than in other collaboration media. Moreover, collaboration is guided by social behaviors (e.g., use of interpersonal distance) that are triggered in avatar-based interaction (e.g., Bailenson, Blascovich, Beall, & Loomis, 2003). These kinds of behaviors are possible only in face-to-face interaction or in VWs. Furthermore, fundamental features of VWs like the use and modification possibilities of avatars, the import and modification of 3D objects and specific clues of the virtual environment are noted to bring new ways to the collaboration in VWs (e.g., Gu & Tsai, 2010; Ward & Sonneborn, 2009). These enablers make VWs a successful media for collaborative actions that are often mentioned in VW literature. Such widely discussed forms of collaboration are, for example, co-creation and training (Helms et al., 2010; Pollit, 2007). A conceptual model based on above mentioned aspects in innovative VW collaboration is depicted in Figure 1. The parts of the model are highly intertwined: the effects of technological features are dependent on psychological and behavioral processes and both of these support different forms of innovative collaboration.

Forms of innovative

collaboration

in distributed work

Psychological and

behavioral enablers

of innovative collaboration

Technological

features as enablers

of innovative collaboration

**Figure 1. The intertwined key aspects of** **innovative distributed collaboration in VWs.**

Note that the model is simply used to structure this article drawing on existing VW literature (see above) and we are by no means using it as a testable model in this qualitative study. Instead, our research questions are:

1. How can psychological processes, social behavior, and technological features of VWs enable innovative collaboration in distributed work?
2. What forms of VW-based collaboration are found to be innovative (i.e., new or improved than other ones) in distributed work?

We follow the above model (Figure 1) in this article in order to discuss and relate current research findings and suggestions on VWs with interview data from VW users and managers with experience on VWs. The interviewees were asked in multiple ways how a virtual world could support innovative collaboration in distributed work, based on their own VW experiences. The comparison of literature and interviews teases out the linkages between VW literature and our focus, innovative distributed collaboration. Finally, and perhaps most interestingly we have a possibility to find new enabling mechanisms and collaborative uses or, at least, enrich the picture provided by current VW literature. Naturally, this last point works the other way as well: the points that are well established in VW literature but not found in our interview data force us to consider the limitations of the interview methodology and to make suggestions on what complementary research methods should be used.

The structure of this article is as follows. We follow the model described in Figure 1 and first discuss research findings and suggestions on both enabling factors and on forms in innovative collaboration in VW literature. Second, we present the interview methods of this paper. Third, we go trough the results from the interviews following the structure of our model, thus framing the scrutiny in terms of distributed work. Finally, in the discussion section, we relate literature with our interview results in order to find matches and gaps in literature as well as in our data and methods. Moreover, we discuss critically the limitations and implications of this article.

**Findings and Suggestions in Virtual World Literature**

Below we discuss VW literature according to the framework discussed above. The sections are divided into psychological and behavioral enablers, technical enablers and forms of innovative (distributed) collaboration of VWs. To obtain the literature base used in this article we searched the main electronic databases (e.g., ABIInform, Ebsco, PsycINFO, JSTOR, Emerald) for studies from diverse fields (e.g., psychology and communication) using an extensive list of relevant search terms. We combined such search terms as virtual worlds or virtual environment with terms like collaboration, communication, creativity and innovation. We also utilized the seminal review by Sivunen and Hakonen (2011) on social and group phenomena in virtual environments. Moreover, we conducted a snowball sampling from the references of the found articles.

***Psychological and Behavioral Enablers***

VW literature often discusses psychological processes as mediating factors of or being associated with successful VW collaboration (see Nowak & Biocca, 2003). These psychological processes are (a) a sense on immersion, which is the feeling that the user is inside the media; (b) social presence or co-presence as an active perception of each other; and (c) engagement, an intense absorption to the task (Helms et al., 2010; Nowak & Biocca, 2003; Reeves & Read, 2009; Sallnäs, 2005). Moreover, some scholars have considered that presence increases trust, which, in turn, might have positive effects on collaboration in VWs (Bente, Rüggenberg, Krämer, & Eschenburg, 2008) even though the evidence on this point is rather weak. Furthermore, many studies have found that the use of avatars in VWs can affect the attitudes of VW users. The avatar-based interaction has been noted to be useful in cross-cultural understanding (Diehl & Prins, 2008), affect sexism (Fox & Bailenson, 2009) and racism (Peña, Hancock, & Merola, 2009). Some of these attitudes may remain affected even after VW usage. Finally, an increased acceptance of persuasive communication from similar avatars has been found (Guadagno, Blascovich, Bailenson, & McCall, 2007).

The behavioral side of psychological processes has been discussed in literature on proxemix. Antonijevic (2008) studied nonverbal communication in VW and found that user-defined non-verbal communication had a strong potential to enhance interaction in multi-user, 3D virtual environments. Many researchers have found that VW users react similarly to avatar proximity as they do in real life. Persons hold an interpersonal distance between avatars, that is typical for real life interactions, and compensate forced proximity by gaze avoidance (Bailenson et al., 2003; Bailenson, Blascovich, & Guadagno, 2008; Yee, Bailenson, Urbanek, Chang, & Merget, 2007), express prejudices by high interpersonal distance (Dotsch & Wigboldus, 2008), and compassion by walking close to a person (avatar) in need (Gillath et al., 2008). Consequently, if one comes close to other’s avatar in order to signal, for example, trust that may enable a new type of collaboration and interaction pattern that is not possible in other CMC media of distributed work.

***Technological Enablers***

One of the key technical features of VWs is the possibility to be represented by an avatar that can be modified. Teigland, Kohler, Helms and Giovacchini (2011) proposed that the more the appearance of the avatars in a VW is aligned with the purpose of the VW and co-creation session, the greater the quality of knowledge externalization and consequent co-creation. Ward and Sonneborn (2009) claim that possibilities to manipulate of how avatars appear to others have positive effects on creativity. Moreover, the current VW literature has found some rather clear results on what kind of avatars are appreciated. People tend to like avatars that are similar to their own avatar (Bailenson et al., 2008) or mimic one’s avatar or real-life self (Bailenson & Yee, 2005), are of a similar gender (Nowak & Rauh, 2005), and are perceived to be attractive or tall (Yee & Bailenson, 2007; Yee & Bailenson, 2009; Yee, Bailenson, & Duchenaut, 2009). Furthermore, some studies (e.g., Feldon & Kafai, 2008; Talamo & Ligorio, 2001) have investigated the identity construction in avatar-based interaction. The results point largely to the same direction. The most common way of shaping one’s virtual identity was customizing the avatar appearance.

Another important technical feature is the possibility to import, modify and interact with 3D objects. Although many suggestions are discussed in literature on the import of 3D objects in VW only few empirical studies have been conducted to assess the impact of this feature on distributed collaboration. Gu and Tsai (2010) imported, presented and demonstrated the usefulness of an interactive graphical tool for collaborative architectural design in VWs. The tool allowed designs to be developed simultaneously and to be represented interactively in multiple ways which were linked together and automatically updated if one element within the system of links was modified. This kinds of features become increasingly important as more and more VWs allow 3D model import and interaction with them.

Next to 3D models, physical clues have been discussed in VW literature to be a support for collaboration. Larach and Cabra (2010) found that VWs enable flexible means of providing clues of the intended behavior for participants by seating (e.g., teamwork vs. lecture), information sharing (e.g., what is important) and colors (e.g., role in exercise). Ward and Sonneborn (2009) introduced the construct of individualized collaboration, that is the notion on users ability to manipulate not only their avatars but also the conditions under which collaboration takes place. Unlike in real-life, VWs have properties that make it possible for individuals to personalize their group work experience (Ward & Sonneborn, 2009). This, in turn, was argued claimed to positively affect the group members’ creativity. In other words, VWs offer users the opportunity to modify features of the context and environment (e.g., view, brightness, etc.) that do not necessarily affect the experience of others but might make their own experience more satisfying or engaging.

***Forms of Innovative Collaboration***

Co-creation and its enablers are a rather common theme in VW literature and the reasoning on these aspects draws largely on the general ideas of co-creation ands open innovation literature (Prahalad & Ramaswamy, 2004; Von Hippel, 2005). Co-creation in VWs has also been labeled avatar-based innovation and current results suggest that VWs can offer new and rich ways to interact with customers and environments during a co-creation process (Kohler, Matzler, & Füller, 2009). The increased number of visual, auditory and haptic cues and better social presence in VWs are argued to improve VWs as platforms of co-creation as compared to other, more traditional CMC tools. Moreover, the playful elements of VWs are considered to contribute to creativity. Specifically, when co-creation is experienced to be inspiring, intrinsically motivating, involving and fun it leads to intensified participation in co-creation (Kohler, Füller, Stieger, & Matzler, 2010). This, in turn, is related to the notions of flow, which is defined as a highly enjoyable and rewarding experience (Csikszentmihalyi, 1975). Flow is suggested to contribute to the level on which users produce innovation relevant knowledge during a co-creation process (Helms et al., 2010). Building on another co-creation research tradition, Larach and Cabra (2010) found similar results. Their participants experienced creative group problem solving in a VW as engaging and immersing and consequently successful.

One of the main drivers for adopting VWs in organizations has been their potential as training tools (Pollitt, 2007). Heinrichs, Youndblood, Harter and Cev (2008) found that VW simulations were useful in training of acute-care medical teams. These kind of simulations have also been called Serious Games and used in teaching and training wide range of skills from medicine to history (Protopsaltis, Panzoli, Dunwell, & de Freitas, 2010) and cultural skills (Zielke et al., 2009). Going briefly beyond professional VWs, many scholars (O’Connor & Menaker, 2008; Reeves, Malone, & O’Driscoll, 2008; Reeves & Read, 2009) argue strongly for the value of 3D multiplayer games in learning business skills. It is argued that the aspects like feedback, transparency and multiple connections can be learnt in 3D games and that they can be implemented in effective collaboration and leadership in real-life business.

VW literature presents a number of topics that can support collaboration. However, few of these studies discuss explicitly innovative collaboration in distributed work settings. Below, after the methods section, we present the results of an explorative interview study to see how the suggestions and findings from literature are in line with the experiences of our interviewees using VWs in distributed work.

**Methods**

Sivunen and Hakonen (2011) found that only few studies discuss VWs in relation to professional distributed work. Therefore, we conducted 47 semi-structured interviews with VW users from industry on how VWs are currently applied for distributed work and whether they support new forms of innovative collaboration. The experiences of using VWs in distributed work were gathered by interviews as follows. The interviews were either one-on-one interviews in person or on the phone, or group interviews (with groups of maximum three people). We choose to have most interviews not in the virtual worlds since the interviewees worked with many different types of virtual worlds to which we could not have access. However, during the interviews, several interviewees showed us their virtual world, their avatar, and how they worked with the virtual world. In total three researchers held 47 interviews based on a similar interview guideline. Of the 47 interviews we held five interviews with vendors of well-known virtual worlds like Second Life, ProtonMedia, Wonderland, TelePlace and Digitell in order to gain an insight in the current market of virtual world platforms and their possibilities. Furthermore, we held two interviews with experts who specialize in virtual world research and consulting. We held 40 interviews with managers of 12 different global (Fortune 100 and 500) and US companies who all had experience in using professional virtual worlds in their company. The companies were mainly selected because they presented their VW experiences externally (outside the company) in articles, blogs, or on conference presentations, and some were selected based on vendor contacts.

The interviews were structured according to a number of topics: (1) general questions on the function, role, and particular experience of the interviewee in using professional VWs. (2) The topic of benefits and challenges of VWs focused on how the interviewees used VWs for distributed work and for what kind of activities, as well as benefits and challenges of working with VWs. (3) Media aspect questions focused on the type of VWs the interviewees were using, why they had chosen this particular VW, what technological features it had, and how interoperable it was with other systems. (4) Innovativeness took up questions on creativity and how VWs were used to support innovation and creativity. (5) Social processes questions focused primarily on the use of avatars, appearance of avatars and interviewees’ identification with their avatars. The interview guide was developed, checked, and tested iteratively in a larger and multi-disciplinary research group of five people. In order to obtain a common interview technique, many of the interviews were held by two interviewees. The interviews were between 1-2 hours and all interviews were recorded and transcribed. All interviewees read through their transcript interview and confirmed the material.

The transcriptions were coded, categorized and analyzed based on the research question on how a VW can support innovative collaboration in distributed work. In several iterations the researchers discussed, compared, and sometimes re-coded the data through systematic stages (Locke, 2001). We used a qualitative approach based on the methodology of grounded theory that was influenced mainly by Lincoln and Guba (1985). Their analysis method is based on Glaser and Strauss (1967), but limits the scope to the data processing aspects rather than theory development as in grounded theory (Lincoln & Guba, 1985: 340]. Our data analysis was performed in a three-step process (Locke, 2001). The first step was data reduction in which we applied open coding of all the data to tease out dominant themes. From the data we found two main categories 1) collaboration related aspects of VWs supporting innovative distributed work and 2) VW features enabling innovative distributed collaboration. Next to these two categories we also identified the main benefits mentioned by interviewees from companies using VWs in distributed work. The second step applied focused coding in these themes to extract passages related to these two main themes. Within the two top-categories we defined a number of sub-categories that focus on specific areas relevant to this article. The third step was data display in which we made lists and tables of emerging themes and monitored the internal cohesion of the codes. The coding of the interviews was an iterative process between the interviewers in order to increase validation. An additional researcher was involved in a later stage and performed an independent coding procedure that was compared to the codes performed by the interviewers. Only a few discrepancies were found during this coding process between the different researchers, which were then discussed and unified. Furthermore, the conclusions drawn from the codes were presented to some of the companies involved in the study.

**Interview Results**

Of the 47 interviews, we found many statements about general benefits of VWs for distributed work that did not fit to any sub-categories of our detailed analysis. However, these statements were specifically pointing towards the value of VWs in distributed work in terms of rich interaction and the possibilities to have geographically dispersed events without limitations of time-zones, geographical boundaries, or burdens and costs of traveling. These experiences supported our initial belief in the potential of VWs in distributed work.

***Psychological and Behavioral Enablers***

When discussing psychological processes that enable innovative collaboration many interviewees mentioned the fact that people are very engaged and immersed in VWs. Several interviewees discussed the positive aspects of VWs, for instance, that it is very difficult to multi-task when participating in a session in the VW. People pay more attention to the sessions and since it is visible what they do or when they are not actively involved or multi-task (their avatar falls over), people are more engaged. Immersion and engagement were described in many ways:

So what we do see is that people can actually stay engaged and focused on a topic longer in a virtual environment than with, say, audio conferencing and web conferencing. I think it’s because you have control over the environment. In a typical virtual environment, you can walk around, you can choose a viewpoint. There’s more than one thing happening at the same time and you’re able to do more kinds of work. So for example, with web conferencing, you're mostly limited to someone presenting and you’re listening. Whereas, in a VW, I can listen to someone present, but we could also be running breakout sessions or brainstorming sessions.

Next to immersion and engagement, interviewees perceived another psychological process in terms of enhanced social presence and co-presence in VWs:

They actually feel that they’re in a room with the other individuals, with seeing expressions that give them a sense that they are being listened to, that other people are listening as well.

The possibility of VWs to build and sustain trust within a distributed team due to visibility of actions was also mentioned:

You can build trust faster than a telephone call and in part, that’s because each of us can see the actions of each other. In a virtual environment, we have avatars, which we drive around and I can watch you work, which is not true with other technologies. So we have a highly immersive but also highly shared environment where I can watch your keystrokes, I can watch your mouse movements and you can watch mine. It’s symmetric in that we can see each other so if we were talking about something and you took an action item and you could say, "Well, John, I’m going to get started right away on helping you with that," I could literally, if I chose to - I may not choose to - but I could watch you working.

***Technological Enablers***

**Avatars – The key feature of VWs.** In the interviews the avatar was mentioned as important. In line with literature several interviewees noted that the importance and use of an avatar is dependent on the task that is performed:

So for business, so a virtual business meeting, people try to dress their avatar according to the type of situations. So if it is a very formal meeting or whatever, people will try to dress nicely, like in formal real meetings. So people care about their appearance.

Especially the vendors talk about the importance of rich avatars. Most interviewees, however, discussed the importance of having an avatar similar to their real-life self:

I prefer the usage of avatars; it helps in like giving a more friendly kind of approach to the whole thing. And I think the more professional the avatar looks, the better, … and more realistic it looks to what you actually look like in real life, the better it is.

Yet, some perceived avatar appearance as unimportant, and mentioned that the focus on avatar appearance and modification took away the attention of the content: “Sometimes the avatar is completely irrelevant. Because all you want is for people to get into that environment and to interact with a lab facility 1000 miles away.”Furthermore, many interviewees noted that they perceived their avatar as representing a part of their identity:

So there’s a funny story about me showing up and it was in fact the company magazine, and I started showing up in the very first iterations of me, I was in a kilt. I have a Celtic heritage. I wanted to kind of display my Celtic heritage a little bit. But the avatar still looked a lot like me, everybody knew it was me. But I also was wearing some of my culture on my sleeve, if you will. And everybody seemed to like that. And so anyway, the picture shows up of me on a full page of the company magazine in my kilt. And so our CEO and chairman learned of me as the man in the kilt.

Furthermore, in the interviews it became clear that the VW environment and people being represented by avatars lowered barriers for people to talk to strangers or executives also in such events they would otherwise not talk to. The avatars provided people with some sense of empowerment, as well as psychological safety, kind of a mask to hide behind.

**Import of 3D objects as a novelty.** An important feature of the VW, which was mentioned by several companies, was the fact that the VW environment can help to visualize models, drawings, objects, and data in 3D format that is more difficult to do when using more traditional media for distributed work. A citation from the oil industry highlights the importance of 3D modeling in high-risk distributed work:

And the oil industry, you have a lot of data. They do geophysical, seismic, and all the exploring to get data. Tons of data coming up and they're trying to figure out where's the oil and where's the reservoir and what does the reservoir look like and where should we drill? When they drill, that's a multimillion-dollar decision. And so you have this 3D object in a way, this pool of oil down in the ground and you have to decide … and it's a very complex kind of a thing. So the data comes up and first of all, oil companies have these very expensive top-notch people. It all comes to that people, they're experts all over the world. You can't fly them in for a meeting just to say: where do we drill because this is a new field. If you can meet virtually, you pipe the data in and you visualize it. You create this 3D representation of the data and then you walk around and then you have the team of experts, their avatars are there and then they walk around the 3D image and they say, what is this over here…

Although many interviewees mentioned the importance of importing 3D models and objects, few firms used this feature often in their work. The firms that worked with 3D modeling often focused on product and software development, prototyping, design, or the energy industry.

**Physical clues help collaboration.** The importance of physical clues was discussed in terms of developing your own space in order to support collaboration, engagement and effectiveness:

We have a group of engineers. They are one of the top-performing engineering groups as far as delivering things on time. And a lot of these things they are collaboratively working on. What they actually do is that they – they're constantly sitting in Second Life. They've translated that into a virtual world so they’re sitting in there. That's pretty powerful and their efficiency has increased because of that. Now, they're in an oilrig and whether or not that benefits anything, I mean, who knows? As far as the ability for them to have an environment that for an engineer can be something that's really cool – which increases their enjoyment at work. It increases their type of engagement because they got – they're at a refinery.

For professional collaboration, the security and authentication of people in the VW were necessities in order to work together. A sort of modification of individualized collaboration was described at one company as they meet another employee from the same company they can see a tag attached to the avatar. Others discuss that behind avatars you can find a social profile:

More importantly, behind that avatar, we could fill out a complete profile. And so there was as an importance for them that the avatar was in front of them as closely resemble the individual as possible. Well, they have a limited avatar set, but behind the avatar they have a whole profile page. So there’s a whole social networking site behind [name of the firm’s network]. It runs alongside it, where you can enter in your knowledge and experience, photographs, video, anything to describe yourself and you can even write a blog if you want to.

A further crucial point of physical or technological clues mentioned by many companies was the fact that the VW provides a knowledge and data repository of for example conference sessions, discussion sessions, and project work. The knowledge repository is important for the company in order to find, get back to and learn from earlier work performed. It was important for companies to capture, access, and extract data and information when needed:

And then all of the content that’s been created during that session can be exported into a CSV formatted file. So, I can do the work in this space, but I can still take the content – the results of that out into an executable form, so I can do something with it outside of the virtual space.

***Forms of Innovative Distributed Collaboration***

**Place for co-creation.** One of the aspects perceived as important and new for VWs was the possibility of distributed collaboration and co-creation. In a VW, distributed team members can build together, have the possibility to collaborate remotely, and co-create simultaneously.

One interviewee mentioned that it is possible that one avatar picks up a beam, and someone else picks up another beam and you can place them on each other in the virtual space despite geographical boundaries and time-zone differences. Several interviewees discussed the process of joint new idea generation in role-plays, simulations, and brainstorm sessions either synchronously or asynchronously:

The first one is co-creation. So teams create things, and they’ll often create things and leave them, and then expect them to be modified by the next team who’s going to come along and modify them and play with them and leave them. This is a new team practice of build, code, modify code, play with it and so on, and iterate on other people’s ideas. And it works particularly well across time zones. So, I can draw something in a space, and fully expect to wake up the next morning and see that about 15 people have played with it. Which is a teaming element that isn’t really always available.

Some mentioned that being able to visualize ideas and physical data in a shared place helps sharing ideas and creativity for example in brainstorm sessions:

I think it’s an important element to foster the creativity and extend the brainstorming. Because often times what may happen is that your colleague might write something down that you see on the board that gets you thinking about something else that you haven’t thought about. So, now you’re scribbling a new idea, you put that up. And somebody else sees that and it takes them in a slightly different direction. So that concurrent activity allows people to feed off of each other. And that’s really where the productivity – or the creativity in a brainstorming session comes from.

Others discussed different possibilities there are not possible in real life. One example was a team that needed to build a bridge that could be built in several ways, which were physically impossible. The exercise helped in learning how to communicate, collaborate and think “outside the box” on different ways to finalize a project.

The ability to co-create, import your own models and collaborate with geographically dispersed colleagues or peers was discussed in the interviews, these comments relate to the diversity and community aspects of co-creation:

In a 3D virtual platform, you definitely get that ability to develop your community and network with your peers so that you can strike up conversations with people who are at [firm name], maybe they’re peers of other companies, and you can ask them questions and kind of how they solved a problem and how that might help you.

Several interviewees discussed the possibilities to cooperate in a different way with each other either with help of a virtually created setting which was in reality not possible or by collaborating with a community of experts. Co-creation and innovative collaboration, however, are still topics that could be explored much further according to the interviewees.

**Platform for training and learning.** The VW was used often for training sessions to gain experience and knowledge in particular fields. This illustrates the serious games aspect of training. Companies mentioned that VWs were especially well suited for training that are difficult to perform in the real world. Many scenarios and hands-on training sessions are either dangerous or very expensive to execute in real life and therefore the VW was used to train people. Especially for distributed work, these training sessions could become very expensive when all geographically distributed people need to travel to a training session. One example was mentioned by an oil company discussed the training of what to do when an oil platform explodes. Another interviewee discussed simulations or serious games for hands-on medical training in which a VW was used for training aspects that are difficult or impossible to train in real life:

We have our patient who is pregnant and bleeding because she was in an auto accident and so a trauma affecting the pregnancy [can be trained]… it is hard to get those data [in real life for training]. We don’t have a lot of photographs of authentic bleeding people.

One of the interviewee companies had good experiences in VW-based cultural intelligence training in order to create more awareness of different cultures present in global distributed teams. The benefits of VWs leadership training came briefly up in interviews when talking about so called inclusive leadership, in which leaders were trained to work with disabled people:

So what are the methods and approaches we can bring these people together? And again, we physically have to bring them together from all over the world to be able to learn about what it’s like to work with a disability. But we also wanted to immerse in scenarios, make them understand and feel what it was like to be that person.

A theme that was noted as important in the interviews was the possibility to transfer information and to share of knowledge and expertise. Several interviewees perceived the learning and sharing of knowledge as an important aspect within a VW that supported their distributed collaboration:

The learning circles, really helping workers – not just get presented on what a new skill is but to now go out and practice that, especially in a team context. So it's not just me doing my job but maybe I have to interact with other colleagues in a work environment. So if you bring them together and then role-play that work environment across different scenarios, that is a very compelling feature that is in the learning and training area very, very critical.

Others used the VW for teaching skills of senior employees to junior ones and some companies applied VWs in order to meet with mentors.

***Other Uses of Virtual Worlds***

In the interviews we found a number of uses and benefits of the VWs that were applied for distributed collaboration, but not often discussed in VW literature. Many interviewees mentioned that the VWs were used in small group meetings, with either ad hoc groups or long-standing groups. VWs were seen better to other meeting tools in distributed work due to increased engagement, focus and productivity:

I’ve been organizing weekly virtual meetings with my team. So, in fact, it was replacing the weekly staff meetings, which at [firm name] I’ve gone mostly using traditional audio conferences. So yes, I’ve run from a virtual place perspective those meetings. And the people were very happy and more active, more productive than using audio conference. People were not sleeping… The meetings I’ve been running where done outdoors where it’s totally – it was a choice to have this outdoors with some trees, where you can see the mountains, the sky and it was more interesting.

Another use that was mentioned by several interviewees and companies was the possibility to have large events in a VW. These events in VWs were initially triggered by cutting travel cost and conference costs, but in many companies the large events held in VW were so successful that these firms continued to have their large events in VWs not solely to because of cost savings. In addition, VWs provided possibilities to cross geographical and time boundaries, and to record all the conference content that could be accessed after the event.

**Discussion**

The interviewees confirmed that the well known VW related psychological processes of immersion, social presence or co-presence, engagement (e.g., Nowak & Biocca, 2003) were perceived to important also in distributed collaboration. In interviews the emphasis and wording were just more practical. Immersion, social presence and engagement were highlighted in terms of staying focused to the task at hand. VW literature presents rather weak evidence suggesting that VWs enhance trust (Bente et al., 2008) but our interviewees highlighted that transparency, that is seeing each others’ actions builds trust, and that this is a VW specific benefit for distributed collaboration.

Regarding the behavioral enablers, proxemics has been established to be an important non-verbal signal for collaboration (Antonijevic, 2008), and a behavioral expression of different attitudes (e.g., Bailenson et al., 2003; Yee et al., 2007; Gillath et al., 2008). These points, however, were not mentioned at all in our interview data. We argue that this is quite natural due to several reasons. First, it was not specifically asked. Second, personal space which affects proxemic behavior is obviously such an aspect of one’s own personality that is hard to be conscious of during interaction and hence in interviews. Moreover, it has been found that persons are not as good at perceiving their behavior as their feelings and sensations (Sivunen & Hakonen, 2009). This point raises the question of the interview methodology’s suitability in mapping actual technology-mediated behavior.

The interviews confirm several findings presented in VW literature about the impact of avatars as representations of VW users (Bailenson et al., 2008; Bailenson & Yee, 2005). However, the avatars used for professional work in distributed settings could often not be modified much and were designed to fit the professional purpose. The notion of avatars as help in constructing (virtual) identity (e.g., Talamo & Ligorio, 2001) was partly transferable to distributed work. Yet, some of the respondents felt that avatars were completely irrelevant for distributed collaboration in a business context.

Of the technical features, the innovative potential of importing 3D objects to VW was as clearly perceived by our respondents as it was highlighted in VW literature (Gu & Tsai, 2010). The benefits of physical clues either in the environment, colors, or individualized collaboration that enhances distributed collaboration were noted in the interviews but with slightly different emphasis as compared to the literature (Larach & Cabra, 2010; Ward & Sonneborn, 2009). Although no explicit stories were presented regarding the increase of creativity due to the use of these physical clues, many interviewees discussed the new forms of collaboration with help of VWs. Two interesting benefits were mentioned. First, the notion was that some company avatars could automatically recognize their colleagues in a VW and see a wide spectrum of information about them, thus helping intra-company networking. Second, the possibility of saving the VW for further use and using it as a knowledge repository was an interesting notion on the potential of VWs in distributed settings.

Regarding the forms of innovative collaboration for distributed work the interviewees recognized the benefits in co-creation, which literature also emphasizes (e.g., Kohler et al., 2009). One of the key mechanisms and success factors of enhancing distributed, professional co-creation was visualization, which was prominent in interviews. Interestingly, co-creation has been primarily discussed as a synchronous process in VW literature (e.g., Teigland et al., 2011). However, the interviewees noted the benefits of asynchronous co-creation due to their context: distributed work is often conducted globally over many time-zones. Moreover, co-creation in VWs was seen to provide opportunities for learning new ways of thinking and for networking.

As has been discussed in literature, many of the interviewees perceived especially training in hazardous situations (e.g., Protposaltis et al., 2010) and cultural training (e.g., Zielke et al., 2009) as important and beneficial uses of VWs. One theme that was noted as important in the interviews, and which has only slightly been touched upon in literature was the possibility of transferring information and sharing knowledge and expertise (see Prasolova-Førland, 2008 for exception). In distributed work, the sharing of knowledge and expertise is an important aspect that is often hindered by geographical distance.

The users who collaborated in a professional and a geographically distributed settings pointed out that small meetings and large events are important forms of collaboration in VWs. However, the VW literature is relatively silent on these VW uses. The interviews revealed that the potentials of having meetings and events in VWs reside in increased productivity and intensified attention as compared to other collaboration tools. An interesting perceived advantage of having large events in VWs was seen in the possibility to record them and return to them later.

In sum, the comparison of VW literature with the experiences of distributed work specialists using that media provided many answers to our research questions. It become clear that psychological processes, social behavior, and technological features of VWs do bring many innovative collaboration potentials to distributed work but they are seen through the lenses of the work itself. The same applied to our second research questions on the forms of VW-based collaboration which are found to be innovative (i.e., new or better that other ones) in distributed work. For example, engagement and immersion were seen as beneficial in preventing multitasking, a major challenge technologically-mediated global meetings. Similarly, the asynchronous co-creation was emphasized due to time zone demands in distributed work. For instance, one team in Europe can start the co-creative process and other team in Asia continue it as they come to work.

***Limitations and Further Research***

Even though our interview data is rather covering, it is mainly gathered from US-based companies. It seems that the first adopters of this relatively new collaboration media are in the US. This may affect the results because of relative homogeneity of national and company cultures. Some aspects that might become more apparent in, for instance, an European context may remain hidden in the US-based companies. On the other hand, the interviewees often discussed the global use of VWs in distributed work and hence reflected a wider cultural context. Another limitation that was discussed above is related to the suitability of interviews in finding out a person’s actual behavior in technology-mediated communication. This has been noted before (Sivunen & Hakonen, 2009) and clearly affected in poor recognition of such behavioral tendencies as using distance as a signal in avatar-based interaction. The studies reporting behavioral signals are either laboratory experiments or observations of actual behavior in a VW. These methods are clearly better in revealing behaviors than post hoc interviews and should be used to complement interviews.

In general, considering and studying VWs in the context of distributed work is still in its infancy. Even though this idea is embedded in much VW literature, its explication, as we have done in this article, should be replicated for validation of our results. VW literature would certainly benefit from cross-fertilization with distributed work and team literature. The open points or mismatches found in our study, that is on trust formation, on the importance of avatars in business context, on added information of same affiliation avatars, on using VW as a knowledge repository, on asynchronous co-creation, on VWs as knowledge sharing tool, and on such forms of collaboration as small meetings and large events call for further research.

***Conclusion***

In this article we addressed the gap of especially VW literature in considering the innovative potentials of VWs in distributed collaborative work. We structured our study by dividing the area of scrutiny into different but intertwined phenomena, that is psychological and behavioral enablers, technological enablers, and forms of innovative collaboration. This conceptual model was used in reviewing the current VW literature, which was, in turn, mirrored against interview data from VW users who work in distributed settings and use VWs in their collaboration. This comparison constituted the core of this article and it provided fresh views on the innovative collaboration potential of VWs in an relatively new organizational form, that is distributed work, which has grown in importance for over two decades. The matches and especially the mismatches found between current VW literature and VW users experiences provided many openings for further research and interesting insights on, yet somewhat underused, potentials of VWs as collaboration media for distributed collaboration.

**References**

Antonijevic, S. (2008). From text to gesture online: A microethnographic analysis of nonverbal communication in the Second Life virtual environment. *Information, Communication & Society,* [*11*](http://www.informaworld.com/smpp/title~content=t713699183~db=all~tab=issueslist~branches=11#v11)[,](http://www.informaworld.com/smpp/title~content=g791552912~db=all) 221–238.

Armstrong, D., & Cole, P. (2002). Managing distances and differences in geographically distributed work groups. In P. Hinds, & S. Kiesler (Eds.), *Distributed work* (pp. 167-186), Cambridge, MA: MIT Press.

Axtell, C. M., Fleck, S. J., & Turner, N. (2004). Virtual teams: Collaborating across distance. In C. L. Cooper & I. T. Robertson (Eds.), *International Review of Industrial and Organizational Psychology*, Vol. 19(pp. 205-248)*.* Chichester, England: John Wiley.

[Bailenson, J. N.,](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-56558?func=lateral-link&doc_number=023907195&line_number=0035)[Blascovich, J.,](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-56559?func=lateral-link&doc_number=023907195&line_number=0036) [Beall, A. C., &](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-56560?func=lateral-link&doc_number=023907195&line_number=0037)Loomis, J. M. (2003). Interpersonal distance in immersive virtual environments. *Personality and Social Psychology Bulletin, 29*, 819–833.

Bailenson, J. N., Blascovich, J., & Guadagno, R. E. (2008). Self-representations in immersive virtual environments. *Journal of Applied Social Psychology, 38*, 2673–2690.

Bailenson, J. N., & Yee, N. (2005). [Digital chameleons: Automatic assimilation of nonverbal gestures in immersive virtual environments.](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-53108?func=lateral-link&doc_number=023907143&line_number=0012)  *Psychological Science, 16*, 814-819.

Bente, G., Rüggenberg, S., Krämer, N. C., & Eschenburg, F. (2008). Avatar-mediated networking: Increasing social presence and interpersonal trust in net-based collaborations. *Human Communication Research, 34*, 287-318.

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety: Experiencing flow in work and play*. San Francisco, CA: Jossey-Bass.

Davis, A., Murphy, J., Owens, D., Khazanchi, D., & Zigurs, I. (2009). Avatars, people, and virtual environments: Foundations for research in metaverses. *Journal of the Association of Information Systems,* *10*(2), 90-117.

Diehl, W. C., & Prins, E. (2008). Unintended outcomes in Second Life: Intercultural literacy and cultural identity in a virtual world. *Language & Intercultural Communication, 8*, 101–118.

Dotsch, R., & Wigboldus, D. H. J. (2008). Virtual prejudice. *Journal of Experimental* [*Social*](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-02808?func=meta-3&short-format=002&set_number=054495&set_entry=000003&format=999##) *Psychology, 44*, 1194–1198. clear

Feldon, D. F., & Kafai, Y. B. (2008). Mixed methods for mixed reality: Understanding users’ avatar activities in virtual worlds. *Educational Technology Research and Development, 56*, 575–593.

Fox, J,. & Bailenson, J. N. (2009). Virtual virgins and vamps: The effects of exposure to female characters’ sexualized appearance and gaze in an immersive virtual environment. *Sex Roles, 61*, 147–157.

Gibson, C. B., & Gibbs, J. L. (2006). Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. Administrative Science Quarterly, 51(3), 451-495.

Gillath, O., McCall, C., Shaver, P., & Blascovich, J. (2008). [What can virtual reality teach us about prosocial tendencies in real and virtual environments?](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-05359?func=lateral-link&doc_number=023907086&line_number=0013) *Media Psychology,* 11, 259–282.

Glaser, B. G., & Strauss, A. L. (1967). The Discovery of Grounded Theory, Chicago, IL: Aldine.

Gu, N., & Tsai, J. (2010). Interactive graphical representation for collaborative 3D virtual worlds. *Computer-Aided Civil and Infrastructure Engineering, 25*, 55-68.

Guadagno, R. E., Blascovich, J., Bailenson, J. N., & McCall, C. (2007). Virtual humans and persuasion: The effects of agency and behavioral realism. *Media Psychology, 10*, 1–22.

Heinrichs, W. L., Youngblood, P, Harter, P. M., & Dev, P. (2008). Simulation for team training and assessment: case studies of online training with virtual worlds. *World Journal of Surgery, 32*, 161-170.

Helms, R., Giovacchini, E., Teigland, R., & Kohler, T. (2010). A design research approach to developing user innovation workshops in Second Life. *Journal of Virtual Worlds Research,* 3(1). Retrieved from <https://journals.tdl.org/jvwr/article/view/819/878>

Hertel, G., Geister, S., & Konradt, U. (2005). Managing virtual teams: A review of current empirical research. *Human Resource Management Review, 15*, 69–95.

Kohler, T., Fueller, J., Stieger, D., & Matzler, K. (2010). Avatar-based innovation: Consequences of the virtual co-creation experience. *Computers in Human Behavior, 27*, 160-168.

Kohler, T., Matzler, K., & Fueller, J. (2009). Avatar-based innovation: Using virtual worlds for real-world innovation. *Technovation, 29*, 395-407.

Lantz, A. (2001). Meetings in a distributed group of experts: Comparing face-to-face, chat and collaborative virtual environments. *Behaviour & Information Technology, 20*, 111–117.

Larach, D. and J. Cabra (2010). Creative problem solving in Second Life: An action research study. *Creativity and Innovation Management, 19*, 167-179.

Lea, M., & Spears, L. (1991). Computer-mediated communication, de-individuation and group decision-making. *International Journal of Man-Machine Studies, 34*, 283–301.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*, Beverly Hills: Sage.

Locke, K. (2001). *Grounded theory in management research,* London: Sage.

Majchrzak, M., Rice, R. E., Malhotra, A., King, N., & Ba, S. (2000). **Technology adaptation: The case of a computer-supported inter-organizational virtual team.** MIS Quarterly, *24*(4), 569-600.

Martins, L. L., Gilson, L. L., & Maynard, M. T. (2004). Virtual Teams: What do we know and where do we go from here? *Journal of Management, 30*, 805–835.

Maznevski, M.L., Chudoba, K.M. (2000). Bridging space over time: global virtual team dynamics and effectiveness. *Organization Science, 11*, 473-492.

Nowak, K. L., & Biocca, F. (2003). The effect of the agency and anthropomorphism on users’ sense of telepresence, copresence, and social presence in virtual environments. *Presence, 12*, 481–494.

Nowak, K. L., and Rauh, C. (2005). The influence of the avatar on online perceptions   
of anthropomorphism, androgyny, credibility, homophily, and attraction. *Journal of Computer-Mediated Communication, 11*(1). Retrieved from [http://jcmc.indiana.edu/vol11/issue1/nowak.html](http://jcmc.indiana.edu/vol11/issue1/nowak.html%20)

O'Connor, D. L., & Menaker, E. S. (2008). Can massively multiplayer online gaming environments support team training? *Performance Improvement Quarterly, 21*, 23-41.

O’Leary, M. B., & Cummings, J. N. (2007). The spatial, temporal, and configurational characteristics of geographic dispersion in teams. *MIS Quarterly, 31*(3), 433-452.

Peña, J., Hancock, J. T., & Merola, N. A. (2009). The priming effects of avatars in virtual settings. *Communication Research, 36*, 838-856.

Pollitt, D. (2007). Learn-while-you-play program get IBM recruits up to speed. *Human Resource Management International Digest, 15*, 14-15.

Prahalad, C., & Ramaswamy, V. (2004). Co-creating unique value with customers. *Strategy & Leadership, 32*(3), 4-9.

Prasolova-Førland, E. (2008). Analyzing place metaphors in 3D educational collaborative virtual environments. *Computers in Human Behavior,* 24, 185-204.

Protopsaltis, A., Panzoli, D., Dunwell, I., & de Freitas, S. (2010). *Repurposing serious games in healthcare education*. A paper presented at the meeting of MEDICON, Chalkidiki, Greece.

Reeves, B., Malone, T, & Driscoll T. O. (2008). Leadership's online labs. Harvard Business Review, 86(5), 59-66. Retrieved from <http://hbr.org/2008/05/leaderships-online-labs/ar/1>

Reeves, B., & Read, J. L. (2009). *Total engagement: Using games and virtual worlds to change the way people work and businesses compete.* Boston, MA: Harvard Business Press.

Sallnäs, E.-L. (2005). [Effects of](http://www.nelliportaali.fi/V/LELPHCDVVGPJMP4HINJSCF5H9H7N2DRPJ195886Q2TL18Q4DNL-13180?func=lateral-link&doc_number=023828799&line_number=0012) [communication](http://www.nelliportaali.fi/V/LELPHCDVVGPJMP4HINJSCF5H9H7N2DRPJ195886Q2TL18Q4DNL-07127?func=meta-3&short-format=002&set_number=057520&set_entry=000017&format=999) mode on social presence, virtual presence, and performance in collaborative virtual environments. *Presence, 14*, 434–449.

Sivunen, A., & Hakonen, M. (2009). *When attitudes and actions collide: Perceptions of CMC and actual CMC behavior in virtual teams.* A paper presented at the 95th Annual Conference of the National Communication Association, Chicago, IL, USA.

Sivunen, A., & Hakonen, M. (2011). Review of virtual environment studies on social and group phenomena. *Small Group Research, 42*, 405-457.

Sproull, L., & Kielser, S. (1986). Reducing social context cues: Electronic mail in organizational communications. *Management Science, 32*(11), 1492-1512.

Talamo, A., & Ligorio, B. (2001). Strategic identities in cyberspace. *CyberPsychology & Behavior, 4*, 109–122.

Teigland, R., Kohler, T., Helms, R., Giovacchini, E. (2011). *Stepping into the internet: Leveraging the affordances of virtual worlds for innovation.* A paper presented at the Faculty Seminar of Amsterdam Business Research Institute, Amsterdam, The Netherlands.

Townsend, A., DeMarie, S., Hendrickson, A. (1998). Virtual teams: Technology and the workplace of the future. *Academy of Management Executive, 12*(3), 17-29.

Von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MA: MIT Press.

Ward, T. and M. Sonneborn (2009). Creative expression in virtual worlds: Imitation, imagination, and individualized collaboration. *Psychology of Aesthetics, Creativity, and the Arts, 3*(4), 211-221.

Yee, N., & Bailenson, J. (2007). The Proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research, 33*, 271-290.

Yee, N., & Bailenson, J. N. (2009). The difference between being and seeing: The relative contribution of self-perception and priming to behavioral changes via digital self-representation. *Media Psychology, 12*, 195–209.

Yee, N., Bailenson, J. N., & Ducheneaut, N. (2009). The proteus effect: Implications of transformed digital self-representation on online and offline behavior. *Communication Research, 36*, 285–312.

Yee, N., Bailenson, J., Urbanek, M., Chang, F., & Merget, D. (2007). [The unbearable likeness of being digital: The persistence of nonverbal](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-72868?func=lateral-link&doc_number=023907112&line_number=0012) [social](http://www.nelliportaali.fi/V/92YNDQI57RGLF13QTEF8QE1191QJKBY16IC67K3LRG3KA9IVFK-72138?func=meta-3&short-format=002&set_number=054495&set_entry=000031&format=999##) norms in online virtual environments. *CyberPsychology & Behavior, 10*, 115-121.

Zielke, M., Evans, M. J., Dufour, F., Christopher, T. J., Donahue, J. K., Johnson, P., Jennings, E. B., Friedman, B. S., Ounekeo, P. L., & Flores, R. (2009). Serious games for immersive cultural training: Creating a living world. *Computer Graphics and Applications, 29*(2), 49-60.