Journal of the Association for Information Systems

Volume 13
Issue 10 *Special Issue on Team Collaboration in Virtual Worlds*

Article 6

10-26-2012

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Imed Boughzala
TELECOM Business School, imed.boughzala@telecom-em.eu

Gert-Jan de Vreede
University of Nebraska at Omaha, gdevreede@usf.edu

Moez Limayem
University of South Florida, mlimayem@usf.edu

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Recommended Citation
Boughzala, Imed; de Vreede, Gert-Jan; and Limayem, Moez (2012) "Team Collaboration in Virtual Worlds: Editorial to the Special Issue," *Journal of the Association for Information Systems*, 13(10), .
DOI: 10.17705/1jais.00313
Available at: https://aisel.aisnet.org/jais/vol13/iss10/6

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Journal of the Association for Information Systems
JAIS

Special Issue

Team Collaboration in Virtual Worlds: Editorial to the Special Issue

Imed Boughzala
TELECOM Business School
imed.boughzala@telecom-em.eu

Gert-Jan de Vreede
University of Nebraska at Omaha
gdevreede@unomaha.edu

Moez Limayem
University of South Florida
mlimayem@usf.edu

Abstract

Virtual worlds are Internet-based three-dimensional (3D) computer-generated environments where users interact through "avatars" – a computer-generated representation of themselves that they control in terms of appearance and behavior. In recent years, virtual worlds have evolved into sophisticated social systems where millions of people regularly collaborate. For dispersed organizational teams, they represent a viable collaboration environment in which users can integrate different communication channels and manipulate digital artifacts that represent actual team deliverables. In this editorial to the Special Issue on Team Collaboration in Virtual Worlds, we discuss past research and highlight key findings with respect to five dimensions of collaborative work: technology, people, information, process, and leadership. We conclude with a discussion of the key research challenges that lie ahead to shape the research agenda for team collaboration in virtual worlds and metaverses.

Keywords: *Virtual Worlds, Metaverses, Collaboration, Virtual Teams, Collaboration Technology, Leadership, Facilitation.*

Volume 13, Special Issue, pp. 714-734, October 2012

Team Collaboration in Virtual Worlds: Editorial to the Special Issue

1. Introduction

Globalization and rapid advances in communication technology have necessitated and enabled virtual collaboration. Individuals are no longer limited or expected to conduct the majority of their work face-to-face. Even though they are located in the same building, employees today often prefer to communicate using virtual work spaces that combine various collaboration functionalities, such as email, video conferencing, versioning control, and data sharing. In recent years, much excitement has built up around a new concept of work spaces called metaverses or virtual three-dimensional (3D) spaces. Metaverses are usually used for sharing information, creating personal virtual images (avatars), and manipulating virtual objects. They are immersive virtual worlds (VWs) in which avatars interact with each other and with software agents (Davis, Murphy, Owens, Khazanchi, & Zigurs, 2009). VWs allow us to move beyond simple electronic conversation and document distribution by providing an environment where people can also share a communal space with others. They mimic the real world but without its physical limitations.

VWs are attractive to workgroups because they can use them to collaborate at any time, provided they have access to a fast Internet connection. The ability to simultaneously work on projects and leave and return to them at will is especially attractive to people who collaborate across time zones. Further, the user capacity of many VWs allows more people to simultaneous work together than most other current tools. Finally, the freedom of expression also draws people to VWs because they can not only actively interact with others, but also control their own appearance and the parameters of the environment. In all, the collaborative potential of groups is exponentially increased in the context of VWs.

However, effective collaboration is not without challenges in the real world, so it is no surprise that we have much to learn before best practices and guidelines can be established with respect to collaboration in VWs. Collaboration, regardless of the medium through which it takes place, is complicated by misunderstandings, interpersonal conflicts, and cognitive challenges. In a virtual world, these difficulties may manifest differently than in the real world, and they are accompanied by challenges that arise from learning to utilize new technology. Consequently, it is important to determine what is already known about collaboration in VWs and which issues must be further investigated. Accordingly, this editorial organizes and summarizes past research on VW collaboration. To this end, in Section 2, we present a model of team collaboration that serves as a foundation to review the existing literature. Then, in Sections 3 to 7, we present key findings and insights for each of the elements of this model. We propose a research agenda to advance this stream of research in Section 8. For all the research that has been completed thus far, team collaboration in virtual worlds is still a young field with many more questions than answers.

2. Collaboration Foundations

Collaboration and teamwork have become pervasive in organizational life. We can see collaboration as a social event that capitalizes on the knowledge, skills, and efforts of several individuals when the action of only one will not achieve the expected result (Levan, 2004). It typically involves two or more agents (individuals, teams, or organizations) that share resources and skills in order to solve problems, so that they can jointly accomplish one or more activities. During this process, the agents communicate with each other to coordinate their tasks (Boughzala, 2007). Simply stated, collaboration is making a joint effort toward a group goal, where joint effort encompasses acts of shared creation and/or discovery.

Collaboration is one of the essential ingredients of organizational life: Organizations form because people have to work together to create value that they cannot produce by themselves. When collaborative efforts are successful, organizations can aspire to be productive and profitable. Yet many organizations struggle to make collaboration work. The collaboration challenges that teams and organizations often face include (but are not limited to) establishing sharing understanding of process, goals, and information (Weick, Sutcliffe, & Obstfeld, 2005), seeking goal alignment

between individuals' private goals and team goals (Ren, Kiesler, & Fussell, 2008), thinking creatively to define and solve problems (Ren et al., 2008; Reiter-Palmon, 2009; Reiter-Palmon, Herman, & Yammarino, 2008), overcoming production blocking, premature convergence, and groupthink (Diehl & Stroebe, 1987; Esser, 1998; Janis, 2008), choosing effective and efficient methods and techniques for collaborative efforts (Kolfschoten & de Vreede, 2009), and selecting among a plethora of electronic and non-electronic support technologies (Boughzala & Romano, forthcoming; Mittleman, Briggs, Murphy, & Davis, 2009).

To explore how teams address and mitigate these and other collaboration challenges when they interact and co-create in VWs, we use an organizing model that conceptualizes five critical elements in a collaborative work practice. As Figure 1 depicts, we can see a "collaborative work practice" as a socio-technical arrangement of people, information, work processes, leadership, and technology employed to achieve a team's goals (Briggs, Kolfschoten, de Vreede, Dean, & Lukosch, 2009). This model serves as an organizing framework to highlight key insights and findings that can be learned from past studies on VW collaboration. The next five sections will address each of the model's elements in turn.

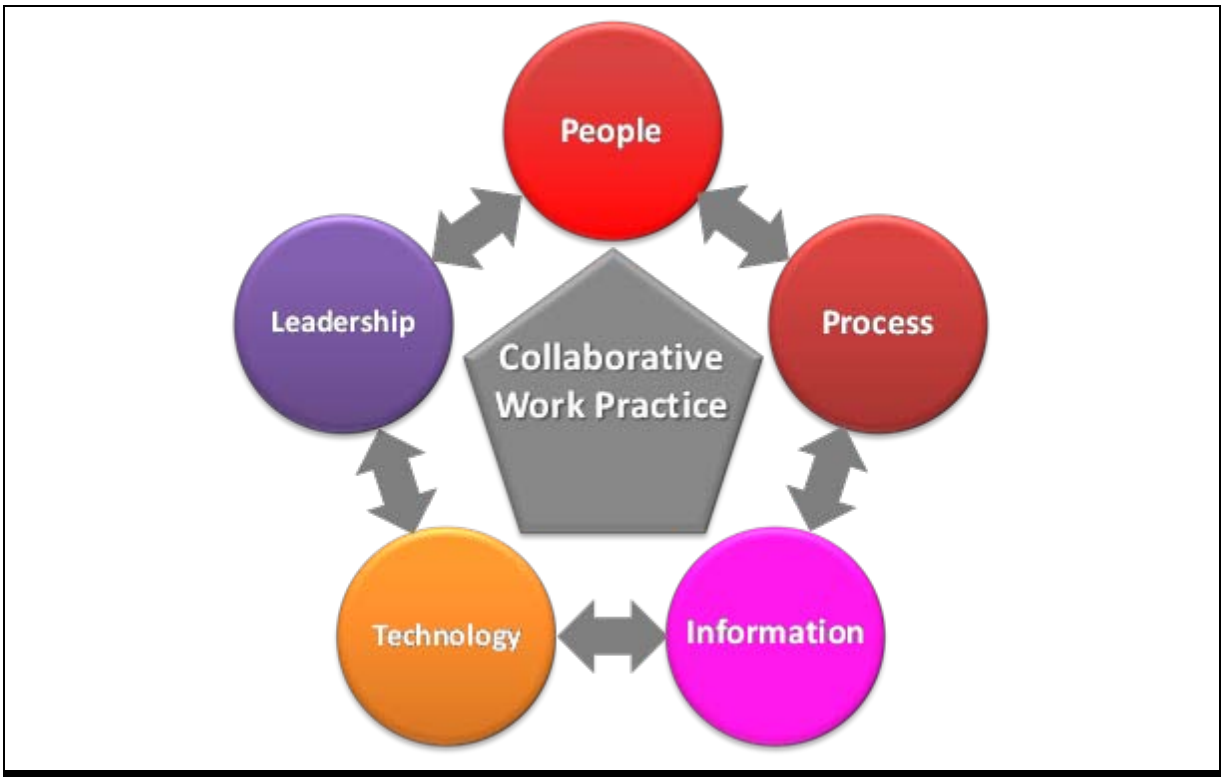

Figure 1. Five Elements of a Collaborative Work Practice (Adapted From de Vreede et al., 2009).

3. Technology

VWs' origins lie in text-based environments called multi-user dungeons (MUDs). These text MUDs evolved into to graphical MUDs with the introduction and advancement of computer graphics (Bartle, 2003). MUDs were later replaced by variants called multi-user dimension and multi-user domain (Bartle, 2003; Kelly, 2004). Today, the primary distinction used to categorize VWs at a macro-level is whether they are a multi-user virtual environment (MUVE; e.g., Second Life) or a massively multiplayer online role-playing game (MMORPG; e.g., World of Warcraft (WoW)). MMORPGs are similar to MUVEs in that users are represented by avatars and interact with other online users. However, in MMORPGs, the user's experience is guided, and interactions are restricted by the game's producer (Papagiannidis, Bourlakis, & Li, 2009). These games have pre-defined goals and

rules (Bessiere, Ellis, & Kellogg, 2009). Conversely, MUVEs provide a more open-ended experience for the user. In fact, users can create more of their own experience because these environments are often modifiable by the users themselves. Like most VWs, MUVE users can customize their avatar and exhibit just about any real-world behavior, such as making friends, interacting socially, holding meetings, shopping, vacationing, and doing business. Also, users can create and manipulate objects/artifacts in their environment, which range from images and tools to complete landscapes and architectural constructions. Objects in MUVEs are created with 3D modeling tools, procedural scripting languages, external software, and/or imported images, animations, objects, and sounds.

An avatar in a VW can exhibit non-verbal communication, such as gestures, eye-contact, and facial expressions when interacting with others. Each avatar has a personal profile that displays information that users share with other users, much like a Facebook profile. Users can add friends to their avatar's profile and join groups of interest. The appearance of the avatars, like that of their human counterparts', influences the impressions other users form of them. Recently, Suh, Kym, and Suh (2011) examined how the physical characteristics of one's avatar influences users' perceptions and intention to use the avatar, as well as their attention to other VW interactions. The researchers found that the more closely an avatar resembles its user, the more likely the user will have positive perceptions – affection, connection, and passion – of the avatar. Subsequently, these positive perceptions are linked to the user's intentions to use the avatar and participate in VW activities. Further, when avatars resembled users, the users could more accurately evaluate the quality and performance of avatar apparel products. This suggests that users became more engaged in VW interactions when they felt their avatar reflected their person. VW researchers and practitioners should take note of this finding because people whose avatar resembles their real self may be more likely to seek out and become immersed in collaborations. However, further research is needed to examine whether users are more deeply engaged when collaborating with a team member's realistic avatar versus a less-realistic avatar.

Several people can simultaneously or asynchronously interact in VWs because these environments continue to function even if no one is using them (Bartle, 2003). User-to-user interactions are primarily supported through text-based chat and voice communication, but various other communication tools also exist, such as videoconferences, whiteboards, and animations. More importantly, VWs can capitalize on cloud computing capabilities and allow users to use software without downloading it directly to their computer. Consequently, VW teams can access specific collaboration systems such as group support systems (GSSs) or shared presentations. Despite the power and reach of VW technologies, it should be noted that practitioners have expressed their concerns that using certain communication tools (e.g., video conferencing, GSSs) within VWs are "over-kill" (Wigert, de Vreede, Boughzala, & Bououd, 2012). In other words, these practitioners argue that there is no need to have meetings in a VW specifically to use a GSS that can also be accessed directly using a web browser.

Research has shown that care has to be taken for novelty and usability effects that can impede the productive execution of the team's collaborative activities. As demonstrated in the early days of computer-support teamwork research, the novelty of technology supported collaboration processes can negatively impact team performance (Hollingshead, McGrath, & O'Connor, 1993). Moreover, VW users must be proficient in VW technical skills in order to take advantage of the technology's capabilities. That is, while avatars provide visualization and realism to the electronic communication, the user must be able to effectively maneuver the avatar in order for collaboration to be engaging. Hence, researchers have highlighted a learning curve related to VW technology usage (Wigert et al., 2012). Linden Labs, the creator of Second Life, indicates that it takes approximately four hours to become a proficient Second Life user. However, most researchers report that novice users (i.e., "noobs") require much more extensive training to become comfortable with managing their avatars (Davis et al., 2009; Hayes, 2007). For instance, users frequently have trouble displaying appropriate body language during conversation as they have trouble maintaining eye contact and gesturing while incorporating text- and voice-based conversation (Hayes, 2007). Noobs are usually so focused on learning to manage their avatars that they have trouble paying attention and contributing to conversation. Furthermore, even experienced users can suffer the detriments of advanced VW

technology because there are more technical issues that can cause problems in VWs than in traditional virtual collaboration settings (Wainfan & Davis, 2004).

From a value standpoint, some authors argue that VWs save more money than traditional means of technology-supported communication because collaborating in VWs has lower start-up and maintenance costs (Wainfan & Davis, 2004). Teleconferencing and videoconferencing require special hardware (e.g., cameras, conference phones, cables) and have relatively expensive service costs (e.g., long distance fees, service fees for connecting callers). Teleconferencing also requires more bandwidth than VW transmissions (Pearlman & Gates, 2010).

Finally, VWs have the potential to provide richer support than traditional electronic collaboration methods (Davis et al., 2009). For instance, an agenda or calendar can easily be displayed in a prominent location in the virtual meeting environment and progress can be tracked in a manner similar to using a scoreboard at a basketball game (Davis et al., 2009). Again, both synchronous and asynchronous work can be done in VWs. Team members can collaborate on a VW project in real-time, or, if they are on different schedules (e.g., different time zones) one user can work on a task and leave the resulting or intermediate artifacts for another user to continue (Kahai, Carroll, & Jestice, 2007). If a large number of people are simultaneously collaborating, smaller break-out groups can be formed during or around VW meetings. Moreover, VW interactions can be revisited as video recordings and copies of text-based chat are easily captured (Davis et al., 2009; Owens, Mitchell, Khazanchi, & Zigurs, 2011). Also, meeting in VWs allows teams to tailor meeting spaces to their needs.

4. People

Regardless of which specific technological platform provides the vehicle for collaboration, people are the most critical aspect of the collaborative work practice. Human/social factors and team climate influence the course of the collaboration process and the quality of outcomes. The literature on the human/social aspects of VW collaboration shows that a particularly appealing topic, to practitioners and academics alike, is that VWs are expected to enhance user engagement over traditional methods used by distributed groups. The primary driving force behind this assumption is that VWs are more engaging because they are realistic and help users forget about their geographic separation (Owens et al., 2011). Engagement refers to a cognitive state in which a person is completely focused on a task (Bakker, Albrecht, & Leiter, 2011). When tasks and/or environments are engaging, one's performance tends to increase, as does one's propensity to experience the psychological state called "flow" (Bakker et al., 2011; Hossain & Wigand, 2004).

Flow occurs when one reaches a state of enjoyment, satisfaction, and control resulting from being fully engaged in an activity (Hossain & Wigand, 2004). In VWs, flow typically occurs due to users' perception of co-existing in a realistic space where one can seemingly interact with others and the environment (Kahai et al., 2007; Kharif, 2007; Owens et al., 2011; Pearlman & Gates, 2010). Specifically, being able to communicate (verbally and via text chat), exhibit emotions and body language, and express oneself via object creation, manipulation, and sharing makes for rich interactions that facilitate flow (Kahai et al., 2007; Pearlman & Gates, 2010). Such richness in communication also promotes high-quality information sharing and trust between team members (Hossain & Wigand, 2004).

Interestingly, some users are more comfortable meeting in VWs because they can control their appearances (Kock, 2008). Low grade videoconferencing equipment may yield poor picture quality and bad camera angles. Huang et al. (2010) found that groups with better videoconferencing equipment tended to dominate meetings, and suggested that VWs can be used to avoid such social biases. Further, Wainfan & Davis (2004) suggested that meeting in VWs would reduce the groupthink that tends to occur in same-location groups during videoconferences. Instead of just (unconsciously) nodding one's head and agreeing with an emergent leader, VWs force group members to deliberately share their thoughts and logic pertaining to a group's issue.

Although VWs are heralded by theorists as a means for immersing individuals deep in their work and improving information sharing, the aforementioned challenges in manipulating avatar expressions and the challenges inherent to the absence of true face-to-face communication can make collaboration in VWs difficult (Davis et al., 2009; Kahai et al., 2007; Hayes, 2007; Wainfan & Davis, 2004). In other words, collaborators in VWs rely heavily on text- and voice-based communication. Therefore, they cannot readily judge the body language of others to collect clues regarding their intentions. These circumstances can cause difficulties for leaders because physical world charisma may not translate to virtual world charisma if the leader lacks adequate avatar management skills (Kahai et al., 2007; Zigurs, 2003). VWs may also have different communication norms. For example, does a pause or non-response by all members signify unanimous agreement, disagreement, or a lag in data transmission? Further, when three or more users are communicating via text-based chat, whose turn is it to talk? Such difficulties may result in miscommunications and even conflict (Kahai et al., 2007).

Unfortunately, the lack of face-to-face communication inherent to VWs can lead to a lack of accountability. Individuals can take advantage of this weakness by social loafing (Walther & Bazarova, 2007). Social loafing occurs when individuals decrease their effort and expect teammates to pick-up their slack (Suleiman & Watson, 2008). Suleiman and Watson found that, when social loafing takes place in VWs, effective interventions can sometimes redirect team member efforts through mechanisms such as self-feedback and identifiability of group members. Yet social loafing is hard to control in large VW groups because users can only see the actions of other avatars; they cannot see what users are doing behind their keyboards. Thus, between miscommunications, conflict, low accountability, and social loafing, it is difficult to build trust in VWs until an adequate amount of time has elapsed to more objectively judge interpersonal relationships (Hossain & Wigand, 2004).

Moreover, the functional weaknesses and social problems associated with VWs, along with the substantial number of distracting activities that may be taking place at any one time in a VW, can be draining on a user's attention-related cognitive resources. This exhaustion of one's cognitive capacity to focus on the task at hand is referred to as cognitive load (Walther & Bazarova, 2007). Due to the inherent cognitive load associated with VWs, researchers often argue that, if a task can be done more quickly via traditional methods, there is no need to log into a VW and risk being distracted from efficiently completing the task (Wainfan & Davis, 2004; Kharif, 2007; Pearlman & Gates, 2010; Walther & Bazarova, 2007).

4.1. Motivation

A key area of interest in the study of VW collaboration is related to the motivation of its users. The extent to which immersion in VW collaboration is motivating for users differs between different types of VWs. Two primary types of motivation with profoundly different behavioral consequences are intrinsic and extrinsic motivation. Extrinsic motivation occurs when an external stimulant or reward entices certain behavior (Deci & Ryan, 2000). Extrinsically motivated behavior is focused on obtainment of a reward that is satisfying and pleasurable. Conversely, intrinsic motivation occurs when one is motivated by the task itself. That is, one gets pleasure and satisfaction simply from working on and/or completing a task (Deci & Ryan, 2000).

Intrinsic motivation tends to be more desirable from an organizational perspective because it is sustainable and does not encourage short-cuts as extrinsic motivation does. Extrinsic motivation provides diminishing returns as people become less sensitive to a reward (i.e., they come to expect or care less about a certain reward). Extrinsic motivation also undermines intrinsic motivation because, once people strive for external rewards, they focus less on enjoying the task at-hand (Deci & Ryan, 2000).

Bessiere, Ellis, and Kellogg (2009) suggest an MMORPG is likely to be extrinsically motivating because users are typically trying to accomplish objectives and earn points to enhance the capabilities of their avatars and win the game. As such, MMPORGs tend to provide opportunities for extrinsic motivation such as goals, score keeping, trophies, and recognition. MMPORGs also provide power motivational factors that can be both intrinsic and extrinsic, such as camaraderie

with teammates and an opportunity to escape reality. Some users enjoy MMPORGs because certain games encourage players to engage in violent and destructive behaviors that are inappropriate in the real world.

Bessiere et al. (2009) further hypothesize that collaboration in MUVEs tends to be intrinsically motivating because users typically participate for creative and intellectual purposes. Of course, extrinsically motivating factors inherent to MMPORGs can be introduced into MUVEs, but the open-ended nature of MUVEs is naturally conducive to exploration rather than to extrinsic rewards. This distinction between the two types of worlds is substantial because it suggests that MUVEs may become more extrinsically motivating when used for work purposes (Bessiere et al., 2009). In this case, motivation to interact in MUVEs is likely to revolve around the achievement of tasks and attainment of rewards, and may be based on the requirements of an employer. Moreover, the open-ended nature and range of required skills and activities available to the user create a challenging learning curve for first-time users. Thus, collaborating in MUVEs for work purposes may be very different and likely more challenging than collaboration for entertainment purposes. As such, factors that influence behavior in MMPORGs cannot be assumed to have the same effects in MUVEs. Researchers need to be aware of these key differences and be careful not to generalize findings across VWs unless they have been replicated in both types of VWs.

The motivational differences between types of VWs have yet to be empirically examined. However, one area of VW motivation that has received substantial attention is new users' intention to engage in VW collaboration (Goh & Yoon, 2010; Chandra, Theng, Lwin, Shou-Boon, 2010; Pike & Murphy, 2009; Vogel, Zhou, Xitong, Wen, & Zhang, 2008). At present, most researchers examining user intention have based their work on acceptance theories such as the technology acceptance model (TAM) (Davis, 1989) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). For instance, Shen and Eder (2008) found that perceived ease of use has a stronger effect on user's intention than perceived usefulness. Furthermore, they found that perceived enjoyment of participating in 3D VWs significantly affected the perceived ease of use (Shen & Eder, 2008).

Goh and Yoon (2010) identified hedonic factors that complement those proposed in UTAUT. Specifically, they studied the influence of inhibitors that may lead to rejection of this technology. Their study indicates that hedonic expectancies have a significant impact on the use and acceptance of VW technology. Based on these findings, Goh and Yoon suggest that existing technology acceptance models should incorporate hedonic influences when examining the acceptance and diffusion of a VW technology. These findings were corroborated in a study by Jung and Kang (2010), who demonstrated that people connect on VWs in order to satisfy their social and hedonic needs and to escape the real world constraints. Similarly, Li, Lee, and Lai (2009) found that users' virtual behavior fulfills their interpersonal relationship needs. These findings, along with those of Chandra, Srivastava, and Theng (2009), who found that cognitive absorption (i.e., being intensely involved in using a technology) and trust played a significant role in the usage of VWs in a collaborative context, suggest that it is users' desire to connect with others that drives the desire to use VWs more so than a fascination with the technology.

Individuals' motivation to collaborate in VWs is likely tied to their abilities to effectively manage both the technology and the activities they participate in. In this sense, it is important to have a thorough understanding of relevant individual VW competencies because they will impact knowledge sharing and transfer in VWs. This is illustrated by Wang and Haggerty (2009), who found that optimal knowledge transfer could be achieved when users possessed the right personal skills and capabilities for successfully interacting in VWs. They found that prior experience in virtual activities also played a significant role in effective knowledge transfer. However, more studies that examine quantitative relationships between specific user competencies and effective VW collaboration are needed to determine the requirements of various participant roles in specific collaboration processes.

Additionally, users' personal characteristics, personality, perceptions, and cognitions influence their motivation to be effective VW collaborators. For instance, Pike and Murphy (2009) studied

the role of sex, psychological traits, and computer self-efficacy on user's intention to use VWs. Their study in Second Life suggests that these three factors are significant and influence the intention to use VWs. Further research is needed to understand what individual differences are most important to users' engagement in VW collaboration. Based on such studies, personality profiles could be built to identify group members most and least likely to work well together. Interventions could also be devised to enhance users' perceptions and expectations regarding the likelihood of learning to effectively collaborate.

4.2. Group Interactions

VWs are socially interactive environments that provide "the opportunity to create strong friendships and emotional relationships" (Cole & Griffiths, 2007, p. 575). As such, early theories of how technology provides a conducive environment to communication and group interactions revolved around social presence and media richness theories. Social presence theory suggests that, when communication is done from a distance, the social influence of the exchange is based on the extent to which technology enables high-quality, realistic social interactions. The theory specifies that more realistic communications increase presence; that is, the intimacy, immediacy, warmth, and interpersonal rapport of communication (Short, Williams, & Christie, 1976). Media richness theory adds that technology should accomplish the main goals of communication, which are to resolve ambiguity and to reduce uncertainty (Daft & Lengel, 1986). Media richness theory suggests that these goals are typically met when technology is less restrictive. Together, the two theories suggest that the realism and malleability of VW technology make for a powerful collaboration tool.

Media synchronicity theory builds upon media richness theory by suggesting that effective collaboration technology must improve the process by which people work together at the same time with a common focus. Specifically, the theory states that collaboration will be enhanced when the synchronicity capacity of technology matches the needs of collaborators (Dennis, Fuller, & Valacich, 2008). Recent findings support the integration of the three aforementioned theories. In a study examining how VWs affect motivation to perform, Hassell and Limayem (2010) found that presence played a mediating role in the positive relationship between media synchronicity and job satisfaction.

Researchers have also begun to investigate how VW interactions are influenced by the social processes enabled by VW technology. Chandra et al. (2010) examined the role of trust in motivating users to use rich virtual communication medium for collaboration. Their qualitative analysis indicates that perceived social presence and perceived structural assurance play important roles in fostering users' propensity to trust VWs to facilitate collaborative interactions.

Goel and Prokopec (2009) also explored how social factors influenced users' intention to interact in VWs. Their results suggest that perceived social interactions and social awareness are positively associated with cognitive absorption felt when using a VW (Goel & Prokopec, 2009). Importantly, the user's social skills and their perception of the social quality of the technology impacts social interactions and awareness. Thus, the person and the technology determine the potential effectiveness of VW collaboration, whereas social processes affect whether a person becomes immersed in the collaborative process. Further, cognitive absorption significantly predicts user satisfaction and the intention to engage in VW collaboration in the future.

4.3. Personal Challenges and Negative Behaviors

However, the engaging nature of VWs has its detriments, which Assmann, Drescher, Gallenkamp, Picot, and Welpe (2010), Chen, Siau, and Nah (2010), and Goh and Wasko (2010) found when studying factors associated with people becoming addicted to MMORPGs (dependency). Chen et al. (2010) proposed three predictive models of MMORPG dependency and tested them empirically using a survey of online game players. They found that multimedia realism for social interaction could serve as an original antecedent to factors causing MMORPG dependency. According to Chen et al. (2010), these mediating factors are derived from uses and gratifications theory (Ruggiero, 2000) and include: participation in a virtual community, diversion from everyday life, and a pleasant MMORPG aesthetic experience. This study indicates that participation in a virtual community has a significant positive

relationship with MMORPG dependency. Interestingly, aesthetic experience had a modest negative association with dependency, while gender was unrelated to MMORPG dependency.

Other negative behaviors have been examined in VWs. Chesney, Coyne, Logan, and Madden (2009) studied "griefing" and its impact inside a VW community. Griefing occurs when a user is socially teased or harassed by another user or users. The researchers discovered that, while this behavior is considered "unacceptable", it is common and persistent in many VW communities. Griefing is typically targeted at beginners (inexperienced VW residents frequently called "newbies" or noobs as previously mentioned) by people with more knowledge of VWs (Chesney et al., 2009).

In a similar stream of research, Brown, Fuller, and Vician (2004) focused on computer anxiety and communication apprehension in relation to users' attitudes toward the use of computer-mediated communication (CMC). They found that computer anxiety, oral communication apprehension, and CMC familiarity contribute to CMC anxiety, whereas written communication apprehension does not impact CMC anxiety. Additionally, previous research in virtual teams shows that cultural differences in how to appropriately interact with group members may also negatively impact collaboration in VWs (Kayworth & Leidner, 2000; Maznevski & Chudoba, 2000).

Finally, although users may increase their immersion in VW interactions by creating an avatar to look like themselves, realistic avatar characteristics can result in the same discrimination (e.g., racial, gender, attractiveness, etc.) as real-world interactions. That is, discrimination can still occur due to written and spoken language, and an avatar's physical features (Hayes, 2007). Further, avatar characteristics can be problematic when they are primitive or distracting because avatars may not be taken seriously by seasoned users (Wigert et al., 2012). To summarize, exercising freedom of expression may immerse some users in their work, but cause distractions for others.

5. Information

Collaboration efforts require information to generate effective outcomes. Information can be provided to a group, accessed by a group, or generated by it. Sometimes this information concerns a clear identification and definition of the problem the group is working on. Other times, it includes the information, knowledge, and expertise that individual group members bring to the table to engage in effective group decision making.

Information access and management are as important in virtual collaboration as they are in the real world. For example, a study by Kayworth and Leidner (2000) showed that knowledge and technical expertise were positively related to team performance. However, little attention has been paid to this aspect of collaborative work in VW settings to date. This is especially surprising because the key difference between VWs and other traditional forms of electronic collaboration is that information is shared visually in VWs to a greater extent than in other forms of communication. Functionality, such as object creation and sharing, avatar body language, and video conferencing, has taken visual information sharing to a new level for virtual teams. Moreover, VWs' high level of visualization has been found to be promising for multi-sensor data fusion improvements (Hall, Hall, McMullen, McMullen, & Purselm, 2008). As visualization impacts the way humans interact with data fusion systems, VW technology could potentially improve multi-analyst collaboration (Hall et al., 2008). Hall et al. argue that the use of VWs could enhance data understanding by engaging analysts' visual pattern recognition capabilities and thus provide new mechanisms for hypothesis generation and understanding.

6. Processes

A collaboration process comprises a series of activities or tasks that a group has to complete (Briggs et al., 2009). Some researchers argue that well-orchestrated collaboration processes provide the potential for VW teams to experience great opportunities, efficiency, and effectiveness by means of overcoming daunting challenges such as management difficulties, maintaining individual motivation and focus, building commitment, and promoting trust (Huang et al., 2010). Others contend that VW

collaboration processes can improve productivity by reducing operational costs and employing the most adequate human resources for a task (Townsend, DeMarie, & Hendrickson, 1998).

The execution of collaboration tasks is influenced by several factors, which include (but are not limited to) group size, degree of formality, technology use, and the characteristics of the task itself. For example, task type influences the demands of decision making (Daly, 1993; El-Shinnawy & Vinze, 1998; Hiltz, Johnson, & Turoff, 1986). Nah, Mennecke, and Schiller (2009) studied the impact of task complexity on the teamwork in virtual worlds. They hypothesized that task complexity influences team cohesion and satisfaction with team process and outcome. They further argued that increases in task complexity lead to both increases in the time taken to complete a task and to increases in workload unfairness of members in terms of physical effort required to achieve the task (Nah et al., 2009; Recker & West, 2010).

Few principles or best practices have been published about how collaboration processes can be designed to increase the effectiveness and efficiency of virtual worlds, especially in the context of business teams. One area that has received most attention to date concerns the support of collaborative learning processes in VWs. Indeed, VWs are becoming increasingly popular as a means of pedagogical delivery in higher education (Chen, Siau, & Nah, 2009; Phang & Kankanhalli, 2009; Chen et al., 2010) because they offer great potential to improve and broaden the scope of electronic educational opportunities (Eschenbrenner et al., 2008; Zigurs & Zhang, 2010). VWs are more interactive and provide richer interaction for group-oriented learning than traditional e-learning technologies (Franceschi, Lee, Zanakis, & Hinds, 2009). VWs provide a sense of being in a classroom (Ferratt & Hall, 2009) and allow both formal and informal interactions that further education and knowledge sharing (Bredl, 2009). Interacting formally in the classroom and informally with others allows students to share a kind of quasi-realism that includes joint manipulation of objects, joint development of ideas, and the creation of shared meaning (Franceschi et al., 2009). In addition, these new environments can simulate students' self-efficacy and their outcome expectations (Muñoz Rosario, Widmeyer, & Hiltz, 2008), which tends to breed innovation activities (Wasko, Teigland, & Donnellan, 2007).

Recent studies have affirmed the positive impact of VW use on learning processes and outcomes. For instance, students have reported feeling higher levels of classroom interactivity in VWs than in traditional, face-to-face, classrooms (Chen et al., 2010). Bredl (2009) found that greater immersion in VWs, which he referred to as connectivism, enhanced VW learning outcomes. Robbins and Butler (2010) argue that VW learning environments are more engaging for students who practice project management skills collaboratively. Zhang and Zigurs (2009) studied the influence of perceptions of presence and social presence on student VW learning interactions and task satisfaction. They found that students did not perceive a high level of presence in the VW, nor was there a significant relationship between perception of presence and students' interactions. However, students' perceived social presence was positively related to both perceived interaction and students' learning satisfaction. Finally, Hassell, Goyal, Limayem, and Boughzala, (2009) hypothesized that users of VWs would perceive themselves as being able to interact with others and share pleasurable experiences and, consequently, be more likely to experience positive learning outcomes (i.e., satisfaction and effectiveness). The authors discovered that flow experienced in VWs was actually negatively related to the observed learning outcomes, and they did not find any significant differences between traditional face-to-face and virtual learning in regards to either learning satisfaction or effectiveness.

To sum up, these mixed findings suggest that the connection between users forged in VWs enhances collaborative learning processes, yet feelings of environmental realism appear to not be directly related to collaboration outcomes. Furthermore, in spite of the great potential offered by VWs to enhance distance learning, educators and technology designers are facing several challenges to creating high-quality, efficient learning environments (Ferratt & Hall, 2009). For example, some challenges are related to the willingness to adopt technology and the factors that attract students to VWs (Zigurs & Zhang, 2010). Several researchers (e.g., Chen et al., 2009; Keller, 2009) have investigated factors influencing students' and academic instructors' intention to adopt VW learning

environments. Finally, Keller (2009) suggests that culture is a salient contextual factor that may impact acceptance of a virtual learning experience (VLE) both positively and negatively.

7. Leadership

To ensure productive efforts, collaborative work typically requires some type of oversight. In VWs, this oversight can take various forms. On a macro level, there are issues that govern the way individuals and teams can be active, interact, and create. Some researchers specializing in law, public politics, and economics have raised questions that address the regulation and governance of VWs, and the emerging virtual economy (Lastowka & Hunter, 2004, 2004/2005; Castronova, 2006; MacInnes, 2006; Malaby, 2006). For instance, the issue has been raised as to whether "virtual properties" that are bought and sold in VWs should be considered property in the legal sense (Mennecke et al., 2007). Lastowka and Hunter (2004) and Roche and Van-Nostrand (2007) raise a "normative" question regarding what constitutes identity theft and fraud in VWs. MacInnes (2004) declared that copyrights are not protected in VWs. In all, there are many questions but few definitive answers pertaining to how legal and societal infractions overlap or diverge in VWs (MacInnes, 2004).

At the team level, oversight of the team's processes typically is the responsibility of a leader or team facilitator. Bostrom, Anson, and Clawson (1993) define facilitation as activities undertaken before, during, and after a meeting of collective decision-making to help the group to achieve its goals. Two types of facilitation exist in the literature – namely, process facilitation and content facilitation. In process facilitation, the facilitator contributes indirectly to a team's final product by managing the communication process via constructive information-sharing (Anson, Bostrom, & Wynne, 1995; Griffith, Fuller, & Northcraft, 1998; Bessiere et al., 2009). In content facilitation, the facilitator contributes knowledge, helps to resolve conflicts, and provides structural guidance to the collaboration process (Eden, 1990).

Like each of the other four primary aspects of collaboration (technology, people, information, and process), facilitation may have different effects in VWs. Wigert et al. (2012) conducted an exploratory study to examine how the role of the facilitator in a virtual world compares to VW facilitation of collaboration. Their findings indicated that interpersonal and leadership dynamics in team collaboration are different than the real world. For instance, because participants are avatars, team members cannot perceive each other's body language. As such, facilitators have difficulty understanding participants' feelings and reactions to collaborative processes. It makes it difficult for facilitators to monitor participants and establish a rapport. This tends to result in miscommunication and frustration between facilitators and team members. Moreover, concerns were raised that facilitators who are charismatic in the physical world may lose credibility in VWs if they are not proficient in technical skills necessary to master avatar movements to mimic physical world gestures, expressions, and movements.

Specific leadership behavior is particularly easy to observe in MMORPGs because they are complex social entities that contain player-founded organizations and mirror real-world interactions (Goh & Wasko, 2009). Consequently, researchers have identified potentially effective VW leader attributes based on social network analysis. Goh and Wasko (2010) explain that player-founded organizations, commonly called guilds, require leaders possessing a set of skills such as managing resources, meditating conflicts, planning, controlling, and motivating (Goh & Wasko, 2009). Like in the real world, these skills are a success key for these organizations. Not surprisingly, IBM and Google are exploring VW leadership characteristics and their applicability to management practice (Goh & Wasko, 2010).

Furthermore, Goh and Wasko (2010) used leader-member exchange theory to study the influence of leadership on team member performance. Their study found that the relationship between a leader and a team member influences the degree to which the member is allocated and develops resources. Furthermore, team performance was positively related to the extent to which a team member receives or develops resources (Goh & Wasko, 2010). This study also found that the quantity and the type of resources allocated to team members impact team performance but not the leader-member relationship.

Although leadership is more difficult to detect and quantify in MUVEs than MMORPGs, it is no less important. An initial empirical study conducted by Hoyt and Blascovich (2003) examined the differing effects of transformational leadership and transactional leadership in VWs. Transformational leadership is characterized by setting followers more challenging expectations, creating mutual respect, and focusing on followers' needs and their higher motives; transactional leadership is characterized by leaders creating motivation through transactions such as rewarding followers with pay for their performance. Hoyt and Blascovich's study revealed that, in comparison to transactional leadership, transformational leadership decreased quantitative performance in three-person teams, but increased qualitative performance, leadership satisfaction, and group cohesion. Interestingly, the authors also found that trust mediated many of these positive relationships, but self-efficacy was not a mediator or antecedent to effective performance. Further, participants were more satisfied with face-to-face leadership than VW leadership when considering both types of leadership.

Notwithstanding these initial studies, VW leadership has been under-researched in the VW literature. Kahai, Carroll, and Jestice (2007) have proposed a research agenda for important VW leadership questions. They placed particular emphasis on the likelihood that many factors will mediate the leadership-team performance relationship, and that leader substitute theory suggests that a team's collaboration context (e.g., environment, task-type, technology) can outweigh the effects or need for leadership.

8. Future Directions

The literature on team collaboration in VWs paints a vital area of research with many useful and interesting studies in recent years. Researchers show that VW collaboration yields new and exciting opportunities for improving virtual teamwork. However, their work also shows that there are a multitude of unresolved challenges. These challenges may impede organizations investing in this relatively new collaboration environment. Table 1 summarizes what we consider to be the most urgent research challenges for team collaboration in VWs. We describe each of them in more detail below.

Table 1. Key Research Challenges for Team Collaboration in Virtual Worlds

1	Determining the antecedents to successful VW acceptance and adoption by teams.
2	Determining the generalizability of findings: • Across MUVEs and MMORPGs. • Across collaborative learning and applied processes.
3	Developing and evaluating solutions and prototypes for challenges related to collaboration process execution, limited functionalities, usability, and security.
4	Expanding and developing theoretical perspectives that adequately describe how users capitalize on VWs' advanced communication and collaboration capabilities.
5	Determining the antecedents to user motivation in VW collaboration processes.
6	Developing theoretical understandings of the fit between collaborative tasks and VW capabilities and processes.
7	Applying and expanding leadership theories to explain team performance in VWs.

First, different types of collaboration systems such as distributed project management software, electronic meeting systems, video conferencing suites, or "e-rooms" have seen different levels of adoption success over the years. One major reason for the organizational reluctance to adopt advanced collaboration tools is that little guidance is available for which tools work best in different contexts (Briggs et al., 2009; Zigurs & Khazanchi, 2008). However, despite an overwhelming number of IS studies focusing on individual-level technology acceptance and adoption, relatively little attention has been paid to team level acceptance and adoption. This is an even more critical challenge in the area of VWs because many VWs are capable of integrating different types of collaboration systems (e.g., video conferencing, GSSs, etc.) into their platform to offer teams a rich yet complex suite of

collaboration support functionalities. It may be the case that implementing certain additional collaboration functions into VWs may actually detract from the content and focus of team discussions and make technology adoption more challenging. At the same time, advances in VW functionality and improved user training may also positively change the (perceived) utility of VWs for the purpose of collaboration. Therefore, further systematic research is needed to identify the antecedents of VW acceptance and adoption in teams.

Second, as Second Life and WoW are presently considered to be the most-frequented VWs, it is important to emphasize that collaboration in MUVEs is different than in MMORPGs. Collaboration in MUVEs tends to mix entertainment and intellectual purposes, which tends to intrinsically motivate users, whereas collaboration in MMORPGs is motivated by a higher degree of extrinsic motivation via goal-focused behavior (Bessiere et al., 2006). Therefore, research conducted using MMORPGs should not be assumed to generalize to MUVEs. Differences between MUVEs are also likely to be significant, especially when the focus is on different application domains. For example, collaboration in educational environments is expected to substantially differ from collaboration in applied settings because participants experience different sources of motivation and utilize different resources (e.g., established versus ad hoc teams). In sum, the generalizability of findings and theoretical insights across different VWs and VW collaboration processes requires further study.

Nevertheless, collaboration in either type of environment is likely to be more challenging than face-to-face collaboration. Indeed, in VWs, the lack of body language that is inherent in face-to-face communication could lead to several social problems such as confusion, misunderstandings, interpersonal conflicts (Cahalane, Feller, & Finnegan, 2010), violation of group norms, and difficulties in building trust between users (Bessiere et al., 2006; Yee, Bailenson, Urbanek, Chang, & Merget, 2007). Moreover, technical challenges of VW collaboration add complexity to collaboration because users have to split their attention between effectively using VW functions and focusing on the task at hand. Users who are uncomfortable with the technology may also become uncomfortable with sharing their ideas. In fact, technical expertise and experience in using VW technologies has been found to positively influence the success of virtual teams and their satisfaction with the collaboration process (Bulkeley, 2007). In addition, VW software requires high technical capabilities, which can burden computers and cause many problems such as operating system delays and shutdowns (Bulkeley, 2007). Shalini, Theng, O'Lwin, and Schubert (2010) argue that, even if VWs are considered as new relevant channel for workspace collaborations, several firms that made a strong initial entrance into VWs are stepping back. This reaction is due, in part, to issues related to reliability and security.

At any point in time, researchers are limited to examining users' perceptions of the potential effectiveness and trustworthiness of the current state-of-the-art VWs. Rather than simply noting the weaknesses of VW collaboration and VW technologies, a third promising avenue for future research is to develop and evaluate solutions to the aforementioned problems. One area could be the development of generic trainings aimed at improving user skills and understanding collaboration processes to reduce the negative effects of user proficiency issues. When and how frequently such training are conducted (e.g., days before or the day of collaboration) is likely to affect team performance. Researchers can also play an active role in developing technological solutions and prototypes for specific VW platforms; for example, in the areas of usability and security. As VW usability improves and functionality becomes more intuitive and streamlined, some of the current challenges are likely to subside, but, until then, interventions are necessary to enable teams to unleash the potential of VW collaboration.

Fourth, from a social perspective, VWs are expected to provide users with a higher sense of immediacy than traditional collaboration technologies. Based on media richness theory and media synchronicity theory, it has been argued that a shared environment and avatar-based interaction leads to several benefits such as facilitating process convergence in decision-making tasks by means of increasing shared understanding between different members (Schouten, van den Hooff, & Feldberg, 2010). Specifically, these advantages enhance VW collaboration in regards to improved task performance, formation of team consensus, satisfaction, and cohesion (Meyer & Swatman,

2009; Schouten et al., 2010). However, some studies (e.g., Shalini, Srivastava, & Theng, 2009) have indicated that specific advantages of VWs do not come from the synchronicity of teamwork. Most of these studies also suggest that VWs have opened a new promising channel for collaboration and information sharing. Thus, future studies are needed to determine if other theories, such as channel expansion theory (Carlson & Zmud, 1999), better describe the mechanisms that enrich collaboration in VWs. As with other social networking technologies, the magic is in how people utilize collaboration tools and not solely in the capacity of the technology itself.

Moreover, if it is the nature of collaboration rather than the technology that makes teamwork engaging, a fifth direction for further research would be to examine what interventions and contextual attributes optimize motivation to collaborate in VWs. Similarly, motivational problems, such as social loafing, must be addressed. Do simple techniques, like ensuring that all team members contribute to group efforts or periodically checking to see if everyone is paying attention, adequately reduce social loafing? Also, how does the appearance of avatars affect users' motivation to put forth their best effort in VWs? It may be that avatars appearing as real people make users take VW collaboration more seriously. Unique avatars (e.g., appearing as an animal or other non-human character) may encourage creativity, and similar or identical avatars (e.g., like a droid or robot) may minimize discrimination.

The sixth area of future research concerns fit between team tasks and VW capabilities and processes. Regardless of whether motivational concerns are adequately addressed, certain tasks may be better suited for execution in VWs than other tasks. For instance, tasks requiring a high degree of visualization and object manipulation, such as architectural design and engineering, may benefit from VW collaboration more so than the building of a presentation that can be done by sharing a single PowerPoint file. Although early research suggests that more complex tasks may be more challenging to accomplish in VWs, a better (taxonomic) understanding of the fit between task type, task complexity, and VW team performance is needed.

The seventh and final area for future research concerns leadership of VW teams. VW collaboration rarely occurs spontaneously; a facilitator or leader is typically responsible for guiding collaborative efforts. Yet we still know little about the differences between facilitating and leading collaboration in VWs compared to the physical world. An initial exploratory study by Wigert et al. (2012) identified some key issues that must be addressed in order to establish best practices and weaknesses of VW collaboration. However, further studies are necessary to assess actions and training that may influence facilitator or leader effectiveness. At present, most insights on VW facilitation originate from qualitative studies. Further empirical studies are required to develop a deeper understanding of these issues, especially if such studies could be executed with real VW teams rather than student subjects. The theoretical basis of these studies could benefit from a broader appreciation for existing leadership theories. Discovering how different leadership styles can be conveyed in VWs will help VW team leaders and facilitators utilize such behaviors. Emergent and shared leadership are particularly promising for VW collaboration because these leadership styles offer explanations for how team members can successfully collaborate without a formally appointed leader (CITE). For instance, monitoring all team members is difficult when distributed members are working on a project in different time zones, so shared leadership may help teamwork efficiently and effectively progress. Finally, future studies are needed to determine whether (and to what extent where applicable) contextual factors such as specific technological capabilities and team characteristics may replace or significantly reduce the need for a leader, which the substitutes for leadership theory suggest (Kerr & Jermier, 1978).

9. Conclusion

Electronic communication and collaboration has entered a 3D era. Advanced technologies have made VWs accessible to nearly everyone in industrialized countries. Further, the globalization of business practices and the proliferation of collaboration technologies have catapulted the utility of VWs into the corporate world. Organizations are trying to take advantage of the flexibility of technology-enabled work to create distributed virtual teams and tap into globally dispersed, cross-

functional expertise and competences. Consequently, it is becoming more common for individuals to work remotely in cross-distance, cross-domain and cross-organizational VW teams. Despite the clear potential and some encouraging research findings that have been reported, much is left to be learned about how to foster and facilitate productive team collaboration in VWs.

This editorial serves the dual purpose of providing an overview of key findings regarding various critical aspects of VW collaboration and identifying what important research challenges lie ahead in this thriving area of research. Our overview shows that significant progress has been made along technological, people, information, process, and leadership dimensions. Yet many challenges remain in each of these dimensions. They range from technical and informational to psychological issues. The key areas of the research agenda for team collaboration VW are clear and call for a balanced portfolio of efforts employing a combination of design science, quantitative, and qualitative approaches. We hope that the insights from past research and the exciting opportunities for future efforts will inspire many more researchers to become active in this valuable field of study.

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About the Authors

Imed BOUGHZALA is an Associate Professor at the Department of Information Systems at the Business School of the Mines-Telecom Institute in Paris, France. He received a PhD and HDR in Information Systems from the University of Paris VI Pierre & Marie Curie. His research's interests are related to team collaboration and Knowledge Management. As part of his research, he is working with several French and International companies as an expert in collaboration technology adoption and virtual project management. He is former executive vice-president of the French Knowledge Management Club, a CKO professional association. During the last years, he has been experimenting with Virtual Learning through 3D Virtual Worlds and Serious Gaming. Imed Boughzala is author of several articles and books. He is editorial board member of *Information & Management*. In 2008 and 2009, he was visiting Professor at three universities for three successive semesters: Brunel West London University (United Kingdom), the University of Arkansas and the University of Nebraska at Omaha (USA).

Gert-Jan DE VREEDE is the Charles & Margre Durham Distinguished Professor and the Managing Director of the Center for Collaboration Science at the University of Nebraska at Omaha. He has been a visiting professor at the University of Arizona and the University of Pretoria. His research focuses on Collaboration Engineering, the facilitation of group work, crowdsourcing, and virtual worlds. He is co-founder of the Collaboration Engineering field and co-inventor of the thinkLets concept. He has published over 200 refereed journal articles, conference papers, and book chapters and was named the most productive Group Support Systems researcher world-wide from 2000-2005 in a comprehensive research profiling study. His research has appeared in journals such as *Journal of Management Information Systems, Journal of the Association for Information Systems, Communications of the Association for Information Systems, Small Group Research, Communications of the ACM, DataBase, Group Decision & Negotiation, International Journal of e-Collaboration, Journal of the OR Society, Journal of Creativity and Innovation Management, Simulation & Gaming, Simulation, International Journal of Simulation and Process Modelling, and Journal of Simulation Practice and Theory.*

Moez LIMAYEM is Dean of the College of Business at the University of South Florida. He holds an MBA and a Ph.D. in Management Information Systems from the University of Minnesota. His current research interests include social media, the use of mobile phone and technology in dangerous settings, Customer Relationship Management, Knowledge Management and Social Virtual Worlds. He has had several articles published or forthcoming in many journals such as *MIS Quarterly*, *Management Science, Information Systems Research, Communications of the ACM, Journal of AIS, IEEE Transactions, Accounting, Management & Information technologies, Group Decision and Negotiation,* and *Small Group Research*. Dr. Limayem is or was on the editorial board of several important journals such *MIS Quarterly, Information and Management and SIM.* He won the best MIS paper award at the *ASAC* conference in 1998 and at the ICIS conference in 2003. Dr. Limayem is the past president of the Association of Information and Management. He was also the program co-chair for ICIS 2008 and the chair of the AIM 2007 conference. Dr. Limayem is the current co-chair of the AIS Senior Scholars Consortium.