Virtual Meetings

Walt Scacchi
University of California, Irvine

Abstract
This chapter reviews and examines virtual meetings (VM). VM are meetings where participants are distributed across physical space or time, yet seek/act as virtually co-located in a common place. Computer-mediated VM are the common form or mode of interest. Many millions of people regularly engage in such meetings world-wide, most often in small groups with others known to them. This chapter focuses attention on two different recurring forms of such meetings: VM conducted through online documents or artifacts that may be stored, accessed or transacted via their associated systems and repositories; and VM where participants employ computer-rendered avatars in immersive virtual worlds to denote their presence, identity, and ability to interact with other avatars through online media or experiences.

Introduction
Using online artifacts as informal documents, people act to communicate to others unknown or invisible through the networked media they author. In this form, the world of free/open source software development (FOSSD) projects are a primary example of online venues where remote participants interact and collaborate through online artifacts, most often without any face-to-face meetings. Similarly, via meetings in virtual worlds using avatars, persons control their avatar in ways visible to other people through distant views of their remote avatar puppetry. People who play multi-player online games, like *World of Warcraft, EVE Online, League of Legends,* or others routinely meet and interact with other players (some familiar, some unknown) from remote locations in order to play the game together. But it is common for people to work together in virtual worlds that sometimes act like games, while some multi-player game play resembles complex workplace activities, like planning team-oriented game combat or competition [Bainbridge 2010].

In both forms of VM, participants meet for any of a wide variety of purposes through computer-mediated environments, rather than face-to-face. Additionally, both may provide different kinds of affordances that enable or inhibit the various VM purposes. But in either form of VM, the perceived/actual distance among participants can matter, whether in space, time, place or cultural practice [Olson and Olson 2000]. Initially, this distinction was employed to help categorize online technologies and work practices that were either local or remote (space) and synchronous versus asynchronous (time) [Shneiderman and Plaisant 2006]. This formulation of the space-time distribution of VM however did not readily tease out what affordances facilitate, constrain, or inhibit VM participants ability to enact routine or new ways of collaborating, transferring knowledge, making decisions, or enacting behavioral outcomes. Subsequently, Olson, Olson and others [Olson and Olson 2000, Olson, Zimmerman, Bos 2008] examined how scientists and others collaborate at a distance through information technologies and found workplace conditions and local cultural practices also matter, and so found that: group communication requires common ground for mutual understanding; communications that are tightly coupled or that entail ambiguous evaluation by the participants may exclude those unfamiliar; collaboration benefits from the readiness of participants to work together; participants who come ready to use online VM technology will be better prepared for collaboration; and differences in participant time-zones, native culture and first languages, and trust mediate or undermine the effectiveness of VM. However, it is unclear whether VM practices in FOSSD projects,

or in multiplayer computer games and persistent online virtual worlds (CGVW), are best explained by these characterizations, or whether there is more to be surfaced from examination of VM practices in such online environments. This is part of what will be addressed in this chapter.

Overall, we are well-informed to recognize that VM are not without their challenges and successful use or practice cannot be readily assumed. However, socio-economic pressures and technological advancements may encourage their adoption and routine use. As such, attention in this chapter focuses on examining how the two alternative forms of VM facilitate or complicate socialization, knowledge transfer, decision-making and rationalization, and practical action outcomes.

Topics not addressed in this chapter include whether VM: have agendas; are planned and structured versus unplanned and improvisational; enable different participants roles in attending or contributing; employ explicit means for assessing the efficacy of meeting processes or outcomes; using smartphone or tablets by co-workers gives rise to new kinds of VM types or outcomes; have robust encryption or cyber-security capabilities; and the like. All of these issues merit serious study and careful explication, but are beyond what we address here. Similarly, meetings that primarily employ only phone/voice conferencing, videoconferencing, or Web-based conferencing are not in focus, though they are all widely used. But when these communication modalities intersect with the two VM forms in focus, we examine their relevance, mediation, or affordances in support of social interaction through online artifacts or through avatars.

VM through Online Artifacts, Artifact Systems and Repositories

Can people meet and collaborate at a distance within documents or online artifacts? Increasingly, the answer is yes. More people are acquiring and practice the skills of how to do so with growing frequency. Such capabilities are enabled through technological affordances like Internet access, Web-based systems, and social media. People are learning how to collaboratively read, write, and edit online documents using services like *Google Docs*. However, many kinds of online artifacts look and function less like formal documents and more like intertextual multi-party communication streams or genre ecologies [Bazerman 1994, Spinuzzi 2006].

Online artifact systems that enable instant messaging, threaded discussion forums, email transactions, Web page viewing and navigation, personal/group timelines, video tutorials, subscription news feeds and tweets, file sharing and versioning, and others are all becoming virtual online places where people will meet, communicate, decide, and rationalize what to do, and how to do it [cf. Scacchi 2010a]. Clearly, these are diverse media for communication and social interaction, and how one works or is used for meetings is different than the others. Yet as interactive social media broadly construed, they serve as online spaces/places where dispersed participants can communicate, collaborate, coordinate action, cooperate or express conflicts and competitive positions. Further, it is common that sustained groups, communities, or enterprises adopt intertextual collections of some of these informal media as a genre ecology for routine online work that supplement or displace the role of formal documents within the organization of work [Orlikowski 2000, Scacchi 2010a]. To help explain this, we use the domain of FOSSD projects, which span from small-group efforts to global multi-national communities where people work to develop, deliver and share complex software systems, but rarely meet face-to-face to collaborate their work activities or outcomes.

In many global FOSSD projects, there is widespread reliance on shared informal software development artifacts that serve as both the workspace and workplace for FOSSD activities—artifacts found in project discussion forums, in persistent Internet Relay Chat (IRC) channels for instant messaging, in project Web pages (content management systems), and more [Elliott, Ackerman, Scacchi 2007, Scacchi

2010a]. More succinctly, collaboration in FOSSD projects happens within and across online software artifacts that are enabled (and constrained) by the underlying artifact repositories that are organized and managed using different storage schemes. This occurs in part because FOSS developers are often loosely coupled and governed through informal online artifacts and tools usage protocols (e.g., in build and release activities that are coordinated and synchronized through software version management systems like *CVS*, *Subversion*, or *GitHub*) [Scacchi 2010a]. So this helps to surface that online artifact repositories that underlie and afford the usage of related online artifacts are a critical part of the socio-technical infrastructure that enable seemingly sparse artifacts become situated as online work places. Said differently, collaboration between spatially and temporally dispersed FOSS developers is enabled through persistent, informal artifacts that are stored, shared, and updated within or across online repositories through end-user system interfaces.

Last, massively open online courses (MOOCs) are emerging as scalable VM spaces for classroom-lecture style education and training. Many MOOCs offer online, Web-based access to video lectures/tutorials traditionally presented in academic classroom settings, along with links to online reading materials, quizzes/exams, and student discussion forums. However, MOOCs also serve as a common modality for sharing and socialized articulation of knowledge, rather than just as a venue for communicating informational knowledge through pre-recorded (or live) broadcast lectures. Whether MOOCs are effective for learners, or what affordances and experiences make them most effective, remain open questions at present. But as the costs for higher education grow to create barriers to entry, along with exponential growth of global demand for underserved communities to gain open access to higher education resources, socio-economic demand for MOOCs is likely to continue to expand. This in turn points to the likely growth in empirical studies that seek to identify the ways and means that afford: (a) better production and delivery of MOOC artifact content; (b) better pedagogical rubrics that configure selected online artifacts, systems, and repositories as different learning genre ecologies; and (c) better preparation of students for online collaboration as a self-managed learning mode.

VM through Avatars in CGVW

Recent analyses of persistent online virtual worlds [e.g., Bailenson, Yee, Blascovich, et al. 2008, Bainbridge 2007, Bainbridge 2010, Boellstorff, Nardi, Pearce, et al. 2012, Bohannon 2011, Pearce 2009, Scacchi 2010b], as well as emerging ventures commercializing emerging CGVW technologies, reveal a diverse, growing set of socio-technical affordances (i.e., new ways and means for net-centric, decentralized collaborative work) are supported and being used in practice by user communities dispersed in space and time. This section identifies and summarizes what such studies and analyses of CGVW have found across ten categories, though none of these categories should be viewed as necessarily more important than the others.

1. Group presentation, communication, conferencing, and interaction – VM can incorporate a sense of place at a distance. Such places may be rendered as graphically modeled meeting spaces where participants will gather to interact and exchange information, coordinate and plan follow-up activities, etc. Many utilize 2D/3D graphically modeled spaces to mirror conventional meeting rooms or classrooms. Integrated software services include support to import and display pre-existing slide presentation decks, static images, or embedded media players for video/audio content, each of which may be sourced from online media content repositories (e.g., *Slideshare, Instagram, YouTube, Pandora,* or local media). In this way, such VM attempt to provide visual appearance of places familiar to people (see Mirrored Worlds and Memorialization below), along with online desktop computing applications. More capable systems also provide the ability to visualize and interactively manipulate 3D modeled objects for meeting participants to view and manipulate, also described below. However, online 3D meeting place designers need not limit the appearance, function, or affordances

they provide to those that only mirror the everyday physical counterparts, as the potential to design VM that are not limited to the meeting place physics, and thus accommodate new modes of presentation, conferencing, or interaction. Some of these are highlighted later.

Next, *graphic chat rooms*, especially those rendered as 2D Web-based graphic worlds, are the most common kind of VM for avatar-based social interaction. Commercial services provided to enable VM are now dominated numerically by those focused on young people as end-users. Virtual worlds like *Club Penguin*, *WebKinz*, *Habbo*, *Whyville*, and a few dozen others report more than 1-10+ million sustaining online users clustered in the 5-17 year old, English-speaking demographic. Some further report more than 1 million unique users per month. In VM in these worlds, end-users meet to chat, hang out, engage in virtual dating, play games, dance, and more generally with others who they do not know in person in the everyday world. Those that target younger users 12 years or less in age, also provide anti-predator safety monitoring and online chat services that employ content-filtering (e.g., cannot ask/disclose personal information), restricted chat vocabularies or pre-formed dialog expressions. On the flip side, the use of restricted discourse universes enables multi-language translation, which in turn allows participants to meet and chat with others around the world with whom they may not be able to talk to due to first-language differences. Young people in these VM thus can learn and practice cross-cultural interactions in a reasonably safe, online manner. Finally, it is worth noting that when young end-users grow up with regular VM experiences, it may well be the case that these users will come to rely on such VM as part of the cultural practices within their online social world and workplaces.

Overall, 3D VM systems are often promoted as a means to displace participant travel costs and burden (including travel time, and related travel contingencies), while seeking to embrace end-users who are comfortable with a sustained online presence [Bainbridge 2007, Bohannon 2011]. This is one of the practical outcomes they may realize. However, 3D VM also represent an alternative to currently available solutions for conventional online conferencing meetings provided by *WebEx, GotoMeeting*, and *Skype,* all of which do not rely on use of interactive or animated avatars to denote a user's presence in a VM. VM avatar systems enable end-users who may have restrictions on physical or social mobility due to age, safety, or other concerns. But young users are growing up in online worlds where VM are socialization places to go with things to do with others that they may otherwise not be able to engage.

2. Training, education, rehearsal, learning – There is growing interest in the use and efficacy of virtual world simulators to support corporate training, academic education and student learning. When multiple users can concurrently participate in the simulated worlds, they may be able to enact simple/complex behaviors to understand how best to use/service a simulated device. Example projects include small-group problem solving within informal science education for students in primary and middle schools, as have studies in corporate settings in the team-training adult technicians in service operations and diagnostic procedures been explored, as have many others [Scacchi 2010b, Scacchi 2012]. In such examples, the ability for groups to play, discover, try-fail-revise, rehearse then commit to an action plan, are all elements of social action that builds from socialization, knowledge transfer, and rationalized decision-making arising from VM experiences. Similarly, the availability of simulated laboratories where experiments with materials that are costly and difficult to manage in the everyday world are modeled in 3D as animated objects that can be engaged and manipulated via avatars, also points to future learning environments for academic subjects that lack laboratory support [Scacchi 2012].

3. Identity role-playing, team building, and other social processes – When users utilize avatars to denote their interactional presence within a virtual world, many may elect to try out other personas and

visual identities. These post-human representations of individuals afford the ability to try to be someone else or someone different from their everyday world physical appearance and social identity. Many successful multi-player games offer preformed characters that vary by gender, in-game role, and role-based skills for players to choose for game play. However, other role-playing modalities can be supported in CGVW. For example, people who may have limited physical abilities, such as being bound to a wheelchair, can enact an online social identity through an avatar that can walk, run, and fly, and therefore exhibit protean virtual abilities [Bailenson, Yee, Blascovich, et al. 2008]. Similarly, for awareness or diversity training, some organizations utilize role-identity reassignment plays, whereby a senior manager make take the role, identity, and virtual appearance (and sometimes gender or ethnicity) of clerical staff members, and vice-versa. Such virtual identify enactment also affords role-play with participants who may be spatially, temporally or cultural distant. In addition, the awareness/diversity distance may be playfully engaged and interactively traversed in ways that the participants may be uncomfortable to try when in the physical presence of other participants, while the identity-play distance manifest through interactive avatar puppets also provides safe ways to overcome perceived authority distancing from others. Finally, playful team challenges can place user avatars in precarious virtual settings (e.g., in a large row-boat that must ferry supplies across a raging river), who must collectively act to achieve shared goals (crossing the river safely without loss of supplies). In this way, multi-avatar VM can be used to train or help people discover new ways for how to work together to achieve shared goals in the presence of challenge, different roles and authority relationships, and risk. It also affords safe engagements through potentially low-cost and fun means. But such capabilities do assume the willingness and competency of participating users in the workplace to be somewhat facile in their use and control puppetry of avatars that operate and interact within a virtual world. Over time, such skills may become more widespread, especially in younger generation workers who have experience in multi-player online games.

4. Mirrored worlds and memorialization – Many people invest significant amounts of personal time and effort to develop and perform with in-game characters or avatars within a virtual world. Sometimes these experiences spans months-to-years, as well as variety of online cultural experiences and rituals [Pearce 2009]. To no surprise, these people become vested in their online games or virtual worlds as a place where they play, interact, collaborative plan, emote, and empathize with others in recurring online meeting places. Sometimes, VM occur in online places where game characters or avatars hang out, socialize, form online personal/intimate relationships, create memorials sites or sacred grounds, and more. Other times, the virtual place is invested and socialized through ways and means that actively seek to replicate physical places in the everyday world. As these online places are situated within remote computation servers that may be administratively controlled and operated as online services by third-parties, then these external parties may choose when and how to transform or terminate these online places for financial business reasons (e.g., inability to operate profitably). When such online places are made inaccessible or unavailable to vested end-users, collective effort of the virtual survivors to immigrate and re-establish a similar or alternative place in a somewhat related online game or virtual world emerges [Pearce 2009]. Similar efforts at preserving the memory of those who have passed on, or to re-animate personas of famous people as avatars that can be interactively engaged in situated discourse or interaction, is motivating the establishment of VM places where these "spirits" can be engaged. Whether or not this creates opportunities or affordances for virtual immortality is less the issue, but it points to ways and means by which game-players and virtual world enthusiasts may act to develop VM places where they can encounter and interact with others long gone. Finally, we may expect to see the development and provision of augmented reality device interfaces for VM participants who relish further immersive, replicated world experiences for their virtualized cultural heritage.

5. Multi-media storytelling and avatar control/choreography – Many participants find their situated

work/play experiences are memorable in ways they desire to share with others unable to been there and then. Alternatively, some have observed the interaction of in-game user characters and non-player characters (NPCs) can constitute a kind of online/cinematic storytelling that in turn can be improved and refined through (post-production) use of video editing software. Avid enthusiasts focus on learning and practicing how to control online avatars as virtual actors who enact stories or screenplays using VW locations as theatrical sets for acting. Consequently, many stories portray avatars in group/VM situations where their remotely controlled interaction enact socialization processes, knowledge transfer, decision-making, and consequential behavioral outcomes. Games like *The Sims* were among the earliest to embrace this mode of game play system usage, by providing online repository services for publishing game-based stories that could be both read as literate media, and re-animated through replay of the story within the game. Hundreds of thousands of such stories have been produced and published, and some stories have been viewed or played by comparable numbers of participants. Elsewhere, the practice of recording high-performance game play sessions ("speed runs") to document a player's claim of game play accomplishment gave rise to the practice and software technology called *machinima.* Millions of machinima videos now populate social media sites like *YouTube*. But what machinima and game-based storytelling demonstrate is that people can learn and practice the art of VM as a theatrical modality. Similarly, it demonstrates that VM can be designed and recorded for pedagogical purposes, for entertainment, or as an embodiment of new media literacy in forms that traditional media and organizational practices may be unable to readily realize. Once again, we may anticipate such efforts are likely to be embraced by a new generation of end-users who are comfortable and accomplished with play-working in CGVW.

6. Product prototyping and review – VM that embrace a vision for the future that utilizes virtual reality (VR) technologies for end-user interaction and gesture-based control sometimes stress that value of shared affordances for interactive creation, manipulation and editing of interactive 3D object models to support new product development. In such VM, end-users may be engineers, project managers, sub-contractors, and others who come together as a small group that is most likely geographically dispersed, but working under time constraints that demand rapid turnaround. Major automobile manufacturers are known to employ such VM capabilities to help reduce the cost/time for development and integration of components or sub-systems that will become physically embodied elements of new cars, as a result of iterative prototyping, review and refinement of 3D model placeholders. This in turn implies the need for sub-contractors (e.g., small to medium size manufacturers, or large volume product suppliers) to acquire VM compatible computing systems so that they can readily exchange new product design specifications, simulation or testing results, and manufacturing capacity or supply chain performance indicators. Furthermore, the rapid growth of interest in "do-it-yourself" object making and small-lot manufacturing will help stimulate interest in the practice of new product development via product prototyping, redesign or reconfiguration, and user review through small group VM. These VM capabilities may eventually be engaged through Web-based services or mobile devices. These capabilities may also be blended with new product demonstration and sales, or even with prospective customers at trade shows or in focus groups.

7. New product demonstration, customization or selection – VM places can serve as new product showrooms. This may often be well suited for the everyday sales and promotion of physical objects, especially those that traditionally may not fit within a smaller showroom, due to the size of the object, or those ready for advanced sales due to their status as virtual product mockups. Such showrooms may be used to showcase, demonstrate, and acquisition objects like commercial airliners, cruise ships, hotels and office buildings, hospital and surgical suites, custom homes, heavy equipment, concert hall or stadium seating, and even new automobiles, motorcycles, bicycles, or personal rapid transit pods. Retail store sales of personal items like clothes and fashion accessories may also be supported through

walkup, on-demand user experiences with "interactive mirrors" that utilize augmented reality features to provide product overlays on the person(s) trying on or contemplating object purchase, perhaps also with VM of remote friends or family members chiming in through online chat. The physical objects being showcased or offered for sale often feature modeled and simulated interactive controls for simulated user experience, thus affording "try before you buy" user interactions with object features or controls, yet while protecting new product inventories from shrinkage or damage. Another common capability that VM new product showcases feature is the ability for customers to specify product customizations (e.g., exterior color, interior finishes, upgraded accessories) that can be readily interchanged or reconfigured on demand by the customer, salesperson or sales team. But such capability also affords the product vendor to defer product manufacture cost and time until a completed sales transaction triggers an order to build the customer configured project. This can be especially important when product manufacture entails assembly of sub-systems that are sourced through global supply chains.

Overall, these VM-based product experience or encounters allow for customer walkthrough, simulated user experience from first-person views, and final product feature specification prior to manufacture, delivery, or first-use. Consequently, it is not surprising to expect a growing diversity of new products marketed and sold through VM may be delivered and experienced through Web-based or mobile devices, as well as for those devices populating an Internet of Things.

8. Game development and/or modding – Networked multi-player computer games represent a global multi-billion dollar industry. Game development firms may be large multi-national enterprises, reconfigurable networks of small genre-specific game making studios, or ad hoc communities of enthusiastic players who seek to modify or extend their favorite games when the game product is accompanied with a game software development kit (SDK) for use by end-users. This last category enacts VM to support the game play/modding activities outside or independent of commercial studios. Web-based portals like *ModDB* and *Steam* offer online artifacts that support modder VM, much like they can support FOSSD projects. Game mods are often subject to intellectual property licenses that assert that community development mods are free (cannot be sold for fee), open source, and redistributable to those with licensed copies of the original game [Scacchi 2010c]. However, many game players organize ad hoc VM within the game itself so as to situate their comments or suggested modifications within the virtual world (game level) where they may be most visible to other players during play activities, or can be demonstrated using in-game player avatars.

Through such ways and means, game modders embrace and practice VM that accommodate all of the preceding VM affordances and capabilities, and many do so outside of formal enterprises [Scacchi 2010c]. This may be another reason why formal enterprises value and recruit avid game players/modders as potential employees, because of the VM expertise that they can bring to a firm. Finally, the actions of game modders within games also reveals the shortcomings of the SDKs they employ. Specifically, SDKs are separate from the interactive game world during modding activities, so that it is uncommon for game mod developers to watch, observe, share, and review a prototype mod while it is being developed, rather than waiting for a preview release. While this might seem like a small issue, it does help reveal that within avatar-based virtual worlds like *Second Life* or *OpenSim,* where participants can interactively modify their world in real-time in the presence of others, it is clear that SL and OpenSim are not recognized as compelling game play platforms, thus game development and modding does not typically happen in VM hosted on such virtual world platforms.

9. Socio-technical process discovery – As academic researchers engage in empirical studies of VM activities and practices in different organizational settings, there is interest and research into

articulating what kinds of scientific knowledge or practical action can best be enacted through VM. This raises questions for how best to study and discover what recurring processes and informal work practices arise through the ongoing use of VM in the workplace. Different research studies perform ethnographic or virtual ethnographic approaches to discover socio-technical processes emerging within VM work or play activities [Boellstorff, Nardi, Pearce, et al. 2012]. Others are interested in studies with large quantitative data sets that arise through data mining of low-level user events/transactions through avatar interactions with one another, with NPCs, with situated virtual objects, and subsequently through VM [Seif El-Nasr, Drachen, Canossa 2013]. In either research modality, what is of concern is how best to study VM where dispersed participants interact with one another through avatars, what they do, what kinds of decisions they make, and what consequences follow [Bainbridge 2010]. However, it is also noteworthy that avatar-based VM may afford new ways and means for discovering the dynamics and configurations of different socio-technical interaction processes that are realized through avatar interaction. For example, at this time, we see relatively little practice of multi-site or global software development projects utilizing avatar-based VM, and instead see online artifact-based VM almost exclusively. Why this is so is unclear and understudied.

10. Enabling human behavior transformation – Can people modify, adapt, or transform their individual or group identity, or their behavior, through interactions within a VM? This is a open research question that is being explored in the realm of games for health, and VR-based educational experiments. In the world of games for health, people who may be subject to health challenges that are mediated by lifestyle choices (e.g., obesity, diabetes) or the result of injury (stroke, traumatic brain injury, Parkinson's disease) may seek for new ways and means to improve their quality of life through social interactions in online virtual worlds or through active game play. Many informal pilot studies and formal clinical studies reveal that participants can not only learn healthy lifestyle habits, but that they can also acquire and enact new active behaviors that they previously did not perform. In such online settings, participants most often engage other characters or NPCs, who may be adaptively controlled by the underlying game design, or guided by skilled therapists working at a spatial or temporal distance. Consequently, participants interact with others through recurring VM that are supportive to the needs of patient-participants, which in turn can help people to learn how to better self-manage their chronic care needs, or to accelerate patient recovery and rehabilitation. These patients consequently are observed to accomplish and embody personal transformation which improves their quality of life, at least for some period of time (long-term behavioral transformation studies are yet to be performed or reported). These game-based VM for personalized health care are likely to garner more attention as affordable health care is sustained as a national priority. Tele-rehabilitation experiments with personalized game-based therapies that accommodate the participation of remote therapists, health care providers, and extended family members are thus an emerging form of VM-based health care we may expect to see in the future.

Avatar-based VR experiments with the classroom of the future have begun to demonstrate accelerated learning results can arise for students. In one set of studies, the physics of student avatars was experimentally manipulated so that every student could sit front-and-center in the virtual classroom where students get best attention from the teacher (avatar), while being minimized to the distraction of other nearby students [Bailenson, Yee, Blascovich, et al. 2008]. Such perceptual experience is readily supported through user-specific (client-software) views into a virtual world or VM, something that cannot be easily achieved with a conventional physical classroom. Beyond this, studies also reveal that when students personalize their avatar in a protean or “super-hero” manner, that they learn to be more convivial and socially supportive [Bailenson, Yee, Blascovich, et al. 2008], versus when they adopt avatars they personalize for competitive or “first person combat” play in multi-player games. As such, we may expect to see more studies that seek new ways and means for improving the productivity,

learning, social skills, and negotiation outcomes of people who work through custom tailorable avatars that interact within VM.

Discussion and Conclusions

A diverse collection of lessons or insights can be observed from the review of Virtual Meetings affordances presented in this Chapter. VM can be realized and enacted through online text-based artifacts, 2D graphic meeting rooms, or persistent 3D virtual world meeting places. When complex work activities are focal, as is common in globally dispersed FOSSD projects, text-based online artifacts and associated repository systems are most commonly used. When younger participants learn to meet and socialize online, 2D graphic chat rooms with managed discourse practices currently dominate. Finally, when users are accomplished game players and virtual reality enthusiasts, then persistent 3D CGVW are viable places to meet. But all accommodate different practices for socialization, knowledge transfer, decision-making, and behavioral actions.

Different tools and techniques are both required and afforded for use in VM. But these socio-technical interaction capabilities require different kinds of supporting infrastructures to enable their sustained online use to global communities of potentially millions of people who as end-users want to meet and interact with others in small group VM. Community repositories for FOSSD projects like *GitHub* host millions of shared software project and artifact spaces that are almost exclusively textual, and infrequently graphic or 3D. 3D CGVW are presently well-suited for playful online interactions through avatars, but are much less frequently engaged for routine organizational work practices, though some in-roads are appearing through new production design and demonstration, and identity role play experiences. Training and educational applications that foster VM are primarily based on utilization of passive media that can be readily packaged for broadcast and assessment, more so than for innovative learning experiences that are still experimental at this time.

VM offer the potential to embrace entirely new kinds of VM experiences. Meeting rooms and associated supporting media content need not be limited to mirroring what can be done in the everyday world. Instead, they can embrace new experiences such as where each participant is self-identified and appears in protean form that is self-perceived to be positioned at the meetings center spot, embraces its readiness to collaborate using online artifacts and services at hand, and does so all within a world that is not limited to physics of conventional meeting room places.

New devices that sense or monitor the physical environment or personal information/data space of end-users working within an Internet of Things may afford new ways and means for experiencing VM. The continued growth and diffusion of mobile devices like smart-phones and tablets as portable personal computing/media platforms seems to suggest that new kinds of VM will appear, though it is unclear what form they may take (text-based vs. 2D vs. 3D vs. app-specific hybrids), or which will be most effective in different kinds of local/global VM.

Finally, there is need for growing recognition that new generations of younger end-users will grow up skilled and ready for VM practices. Trans-cultural VM experiences of young people may anticipate a future where VM usage is a necessary element of workplaces and learning systems.

Overall, VM are both exciting and boring venues for online socialization, knowledge transfer, decision-making, and behavioral action. What determines whether such VM are fun, playful, or tedious depends on the capabilities and experiences that are readily afforded for different user-skill demographics, so that what works well for one community or group, may be cumbersome and frustrating for others. So it is unlikely that we can identify emerging patterns of success or failure in enabling online collaboration practices that will be universal, but we do recognize that both successes and failures are common. What

remains to be determined is how best to design, organize, practice and continuously improve/adapt the VM genres so that we can readily recognize when we are working or playing within a productive or unproductive one.

Acknowledgements
The research described in this report was supported by grants #N00244-14-1-0030 from the Acquisition Research Program, at the Naval Postgraduate School, Monterey, CA; and grants #0808783 #1041918, and #1256593 from the National Science Foundation. No endorsement, review, or approval implied.

References
Bailenson, J.N., Yee, N., Blascovich, J., *et al.* (2008). Transformed social interaction in mediated interpersonal communication. In Konijn, E., Tanis, M., Utz, S. & Linden, A. (Eds.), *Mediated Interpersonal Communication*, 77-99. Lawrence Erlbaum Associates.

Bainbridge, W.S. (2007). *The Scientific Research Potential of Virtual Worlds*, Science, 317, 472-476, 27 July 2007.

Bainbridge, W.S. (Ed.) (2010). *Online Worlds: Convergence of the Real and the Virtual*, Human-Computer Interaction Series, Springer-Verlag London Limited.

Bazerman, C. (1994). Systems of genres and the enactment of social intentions, in A. Freedman, P. Medway, (Eds.), *Genre and the New Rhetoric*. Taylor & Francis Ltd., London, 79-101.

Bohannon, J. (2011). Meeting for Peer Review at a Resort that's Virtually Free, *Science*, 331, 27.

Boellstorff, T., Nardi, B., Pearce, C. *et al.* (2012). *Ethnography and Virtual Worlds: A Handbook of Methods*, Princeton University Press, New Jersey.

Elliott, M.S., Ackerman, M.S., and Scacchi, W. (2007). Knowledge Work Artifacts: Kernel Cousins for Free/Open Source Software Development, *Proc. ACM Conf. Supporting Group Work (Group07)*, Sanibel Island, FL, 177-186, November.

Olson, G. and Olson, J. (2000). Distance Matters, *Human-Computer Interaction*, 15(1), 139–178

Olson, G.M., Zimmerman, A., & Bos, N. (Eds.) (2008). *Scientific Research on the Internet*, Cambridge, MA: MIT Press.

Orlikowski, W.J. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations, *Organization Science*, 11(4), 404-428.

Pearce, C. (2009). *Communities of Play: Emergent Cultures in Multiplayer Games and Virtual Worlds*, MIT Press, Cambridge, MA.

Scacchi, W. (2010a). Collaboration Practices and Affordances in Free/Open Source Software Development, in I. Mistrík, J. Grundy, A. van der Hoek, and J. Whitehead, (Eds.), *Collaborative Software Engineering*, Springer, New York, 307-328, 2010.

Scacchi, W. (2010b). Game-Based Virtual Worlds as Decentralized Virtual Activity Systems, in W.S. Bainbridge (Ed.), *Convergence of the Real and the Virtual*, 225-236, Springer-Verlag, New York.

Scacchi, W. (2010c). Computer Game Mods, Modders, Modding, and the Mod Scene, *First Monday*, 15(5), May 2010.

Scacchi, W. (Ed.), (2012). *The Future of Research in Computer Games and Virtual Worlds: Workshop Report*, Technical Report UCI-ISR-12-8, University of California, Irvine, Irvine, CA. http://bit.ly/1tWxUDi

Seif El-Nasr, M., Drachen, A., and Canossa, A (Eds.) (2013). *Game Analytics: Managing the Value of Player Data*. Springer-Verlag, London.

Shneiderman, B. and Plaisant, C., (2006). Collaboration and Social Media Participation, *Designing the User Interface: Strategies for Effective Human-Computer Interaction: Fifth Edition*, Addison-Wesley, Reading, 360-402, MA.

Spinuzzi, C. (2003). *Tracing genres through organizations: A sociocultural approach to information design*. MIT Press, Cambridge, MA.