2018

EXPLORING THE IMPACT OF TECHNOLOGY CAPABILITIES ON TRUST IN VIRTUAL TEAMS

Deepak Khazanchi
University of Nebraska at Omaha, khazanchi@unomaha.edu

Recommended Citation
Dawn Owens, Deepak Khazanchi, (2018) "Exploring the impact of technology capabilities on trust in virtual teams", American Journal of Business, Vol. 33 Issue: 4, pp.157-178, https://doi.org/10.1108/AJB-04-2017-0008

EXPLORING THE IMPACT OF TECHNOLOGY CAPABILITIES ON TRUST IN VIRTUAL TEAMS

Abstract

Purpose – In an environment of constant technological change, the use of virtual teams has become commonplace for many organizations. Virtual teams (VTs) bring together dispersed individuals with varying knowledge and skill sets to accomplish tasks. VTs rely heavily on information technology as the medium for communication and coordination of work. The issue of establishing and maintaining trust in VTs poses challenges for these dispersed workers. Previous research has established that higher trusting teams have better cooperation and experience improved outcomes. We hope to contribute to the literature on trust in VTs by exploring how technology can facilitate high trusting teams. Specifically, this paper reports the results of our research addressing the following questions: *How does the use of technology capabilities afforded by virtual worlds affect the development of trust in virtual teams?*

Design/methodology/approach: We employed a *multiple case study research design*. Each case spanned a two-week period allowing for longitudinal data collection.

Findings: We found that communication, rendering, and interaction technology capabilities allowed participants to use the technology to assess individual capabilities. While this paper answers some questions about how technology capabilities can help develop trust in VTs, it also raises many questions. This study offers a model and framework for further work on this topic and encourages researchers to investigate other social and behavioral issues faced by VTs in a virtual world setting.

Originality/value: – This paper offers practical implications for developing trust in VTs, specifically, how the use of information technology capabilities can facilitate trust development. Our goal was not to recommend a specific technology platform, but rather explore how unique technology capabilities impact behaviors in VTs. The study identified interesting findings relating to how people use technology capabilities to complete tasks and collaborate on a team. These findings may be used to help develop guidelines and recommendations for using technology to enhance work practices in VTs.

Keywords trust, trustfulness, trustworthiness, virtual teams, virtual world, adaptive use, technology capabilities, collaboration

Paper type Research paper

1. INTRODUCTION

Virtual Teams (VTs) continue to face challenges with building trust among team members. A recent meta-analysis reviewed 52 studies with 54 independent samples (representing 12,615 individuals in 1,850 teams) and confirmed that there is a positive overall relationship between team trust and team effectiveness (Breuer et al., 2016). Additionally, the authors reported that the relationship between team trust and team performance was stronger in VTs as compared with face-to-face teams. Prior research on trust has established that creating and maintaining trust in a VT is difficult (e.g. Jarvenpaa et al., 1998 & 2004). Without trust, team members may not openly share information or avoid collaborating with others, thus limiting their productivity (Herbsleb et al., 2000).

VTs rely heavily on information technology (IT) capabilities as the medium for communication and coordination of work. Trust is essential to all relationships and it is based on communication—how, when and what is being communicated (Denton, 2012). Trust is necessary for sharing knowledge and collaboration between individuals (e.g. Anantatmula & Kanungo, 2010; Malhotra et al., 2007; Holste & Fields, 2010; Mitchell & Zigurs, 2009; Peters & Manz, 2007; Chen et al., 2011). The lack of face-to-face interaction typically poses additional challenges for communication and trust development (Zigurs, 2003; Holste & Fields, 2010). Effective communication is critical to keeping the team working together towards a common goal. The continual advancement in IT capabilities offers opportunities to study how technology can facilitate or hamper knowledge sharing, communication, and trust. In addition, the evolving nature of IT capabilities creates new ways for supporting teams, virtual or not.

To understand the impact of information technology capabilities on trust we conducted research within a virtual world setting to explore how its unique features can support communication, interaction and rendering of ideas and interactions among teams. Virtual Worlds (VWs) are three-dimensional platforms where people interact with each other and their environment, using the metaphor of the real world but without its physical limitations (*citation removed for peer review*). VWs offer a synchronous, persistent network of people, represented as avatars, facilitated by networked computers (Bell & Robbins-Bell, 2008). Recent examples of VW technology include Second Life, World of Warcraft, Kaneva, and Minecraft. Although VW technology has seemed to lose its edge in the marketplace, understanding their unique capabilities is important for enhancing our understanding of the role of such features in virtual team development. We chose to focus on VW technology capabilities because of their unique ability to provide three-dimensional facets that are not currently available in traditional collaboration technologies. Specifically, the following research question guides this research: *How does the use of technology capabilities afforded by virtual worlds affect the development of trust in virtual teams?*

In addressing the research question, this research has interesting theoretical and practical implications. First, the research explores the way individuals adapt IT capabilities and how this adaptation can affect the development of trust. The study raises questions about how specific technology capabilities such as communication, rendering, and interaction can allow participants to evaluate trustworthiness and assess individual capabilities. Second, this study introduces a multi-case research methodology that offers unique benefits. This approach uses both qualitative and quantitative data analysis guided by a theoretical framework and affords triangulation through multiple data points. This approach provides opportunities to synthesize the data and identify patterns of explanation. Third, this research contributes to practice by offering suggestions for next generation collaboration technologies to explore specific technology capabilities so individual users can potentially develop a higher level of cognitive engagement in their online activities and communication acts with others.

2. THEORETICAL FOUNDATION AND RESEARCH MODEL

To understand how technology capabilities affect trust in VTs, we explored how individuals used technology in a virtual world setting. We chose the VW setting because of the unique, three-dimensional technology capabilities it affords and their potential to affect trust in VTs. As with face-to-face teams where the environmental context is important in establishing trust, we expected the same to hold true in a VW environment (Bhattacharya et al., 1998). Using prior research models in VWs (Davis et al. 2009; *citation removed for peer review*) we constructed a conceptual model grounded in the socio-technical view of work practice. Figure 1 presents the conceptual model that guided our research.

*** Insert Figure 1 here. ***

Our conceptual model focuses on the interplay between trustfulness, trustworthiness, and the adaptive use of IT capabilities in general, and, virtual world technology capabilities (VWTCs) in particular. The model is grounded in the socio-technical system view of work practices, which takes as its underlying premise the interdependencies between people and technology (Bostrom & Heinen, 1977; Adman & Warren, 2000; Lamb & Kling, 2003). This view provides a theoretical lens to study the impact of VWTCs on both the social and technical aspects of group interaction. In our model, VWTCs represent the technical component, and trustfulness/trustworthiness represent the social component. The arrows and circular relationship suggest the interplay among components. The dashed line around the diagram represents the scope of the study. There are four main components within the scope of this study ***trustfulness***, ***trustworthiness***, ***technology capabilities***, and ***adaptive use of technology capabilities,*** and we focus on the interplay among these components. These components and relationships are discussed in the following paragraphs.

2.1 Trustfulness and Trustworthiness

Trust is ubiquitous in human interaction and central to our study. Prior research on trust, specifically in VTs, has been extensive, spanning many years (Mitchell & Zigurs, 2009). A study by Mitchell & Zigurs (2009) provided an extensive literature review on trust in VTs. They found varying definitions of trust which presents a challenge regarding consistency in definition and measurement of trust. While there is no unified definition of trust, their paper provided a framework for identifying relevant definitions of trust. These definitions share attributes that are important to developing a unified conceptualization of trust. *Trustworthiness* is one's belief that another person is benevolent, competent, honest, or predictable in a situation (Mayer et al., 1995). *Trustworthiness* refers to how another team member is trusted (Chou et al., 2008). This study examines both trust dimensions at the individual level, rather than the group level.

2.2 Technology Capabilities

In order to explore how VW technology can affect trust, we conceptualize technology in terms of capabilities (Bharadwaj, 2000, Mulligan, 2002; Davis et al., 2009). This allows us to examine how individuals on a team adapt specific technology capabilities. Technology capabilities (TCs) provide features – current and yet to be discovered – that are used for a specific functionality as deemed by the user (*citation removed for peer review*). TCs are often bundled together by people to accomplish a specific task. TCs are dynamic - they can change with time through the process of users' adaptation and appropriation (*op. cit.*). Sun & Zhang (2008) found that individuals use features of the same system in different ways and the ways individuals adapt technology can influence trustfulness and trustworthiness (Majchrzak et al., 2000; Henttonen & Blomqvist, 2005).

Individuals often *adaptively use capabilities* to find the best fit between the task and the technology.

Our work focuses on the TCs offered by virtual worlds (VWs), which offer unique capabilities to support communication and coordination. For example, VWs offer TCs that allow individuals to develop three-dimensional objects or artifacts in the environment. Developing artifacts can help people identify with others, which in turn can promote empathetic attitudes that build trust (Hung et al., 2004). VWs also incorporate the elements of unencumbered face-to-face interaction (e.g., physical presence, ability to see and hear others, synchronicity), by providing the ability to transmit emotional and nonverbal cues through an embodied representation of the individual, the avatar. Virtual World Technology Capabilities (VWTCs) can be broadly classified into five categories - awareness, communication, team process, interaction, and rendering (*citation removed for peer review*). Awareness capabilities allow users to participate synchronously and provide a sense of presence within a virtual space. Communication capabilities support communication and collaboration. Interaction capabilities support direct interaction between people and people and artifacts. Rendering capabilities support the process of creating or executing life-like images on the screen. Finally, team process capabilities provide support for process structuring and enable socialization and community building. The following table provides details and examples of these capabilities.

*** Add Table 1 here. ***

2.3 Adaptive Use of Technology Capabilities

To explore the question *How does the use of technology capabilities afforded by virtual worlds affect the development of trust in virtual teams?* – we examined how individuals adapted virtual world technology capabilities (VWTCs) and its impact on trustfulness and trustworthiness.

Technology adaptation is the process by which an individual uses a capability or set of capabilities to perform a specific task (Majchrzak et al., 2000) and encompasses the *inclusiveness*, *usage experience,* and *fit* of technology in interaction. These three primary conditions of adaptive use are derived from our review of prior literature on technology adaptation in VTs and have their foundation in three well-known theories - Adaptive Structuration Theory (AST) (DeSanctis & Poole, 1994), Technology Acceptance Model (TAM) (Davis, 1989), and Task Technology Fit (TTF) Theory (Zigurs & Buckland, 1998). These theories highlight the importance of finding the appropriate technological capabilities for a specific task and acceptance of those technologies. ***Adaptive use of a capability*** then is the process by which an individual uses or modifies one or more capabilities to perform a task (Burton-Jones & Straub, 2006).

Therefore, we have characterized the **adaptive use of technology capabilities** in terms of three well-known attributes **– fit, inclusiveness,** and **usage experience**. First, ***fit*** *is the ideal use of a capability or set of capabilities that affect group performance.* TTF theory defines fit as "ideal profiles composed of an internally consistent set of task contingencies and GSS elements that affect group performance" (Zigurs & Buckland, 1998). Next, ***inclusiveness*** *is the extent to which an individual embraces and utilizes the diverse capabilities provided by the technology* (Yu et al, 2011). Inclusiveness is an initial condition for adaptation and is based on the extent to which a given technology embraces diverse capabilities (Yu et al., 2011). For example, an individual's use of the many capabilities in a multi-purpose electronic collaboration system would be considered as high inclusiveness. Finally, ***usage experience*** *is the user's experience with using and interacting with technologies* (Yu, et al., 2011). Usage experience is relevant in the process of technology adaptation because greater the experience, the more likely a user will adapt the capabilities of the technology to other functions of their work.

In summary, the way individuals adapt TCs has the potential to affect trustfulness and trustworthiness. The socio-technical aspect of our model highlights the relationship between how people use the technical components of VWTCs to achieve higher or lower levels of trustfulness and trustworthiness.

2.4 Institution-Based Trust, Personality-Based Trust, and Project Outcomes

Institution-based trust and personality-based trust have been found to influence one's individual trust levels (Sarker et al., 2003; Peters & Manz, 2007). These constructs have been shown in our model because of their effect on initial trust levels (refer Figure 1). For example, someone may have a high level of trust prior to joining the team because of high levels of personality-based trust and/or institution-based trust. However, these constructs are outside the scope of our study because these types of trust are typically independent of technology and rely on external factors such as one's personality and institutional norms.

Trust is one of the keys to VT success and positively influences project outcomes (Hakonen & Lipponen, 2009). Project outcomes are defined as task-related and team-related outputs for a specific project (McGrath, 1984). Efficient cooperation is only possible when trust exists among individuals (McAllister, 1995) and as a result, trust positively affects performance and project outcomes (Cascio, 2000; Jarvenpaa et al., 1998). However, project outcomes were not included in our study because our focus was on the interplay between capabilities and trust.

3.0 RESEARCH DESIGN AND MEASUREMENT

3.1 Research Design

This study employed a multiple, exploratory case study design using theoretical replication logic to collect and analyze data (Yin, 1982; 2009). Multiple virtual teams were studied and each was considered a "case". The case study research approach allowed for contextual analysis and the ability to study specific interrelationships. Replication logic was used to assist in interpreting the findings across cases (Yin, 2012).

Quantitative research methods were used to measure trustfulness, trustworthiness, and adaptive use of VWTCs, while qualitative data was used to supplement conclusions and provide further explanation of the findings. The combined qualitative and quantitative approach allowed for careful review of combined data sources to identify patterns and offer explanations to help improve understanding of key features of the model.

3.1.1 Task

Participants were assigned the task of working together in a virtual world, Second Life, to construct a three-dimensional Rube Goldberg machine. Rube Goldberg machines are complex, highly over-engineered contraptions that perform a simple activity. This task was chosen for several reasons. First, the task was complex enough to require that participants utilize all the technology capabilities afforded by Second Life. Second, the task's complexity was expected to require team members to work together and rely on each other to complete the project, therefore, requiring team members to develop trust in the other individuals. Third, designing and building a Rube Goldberg machine provided an opportunity to observe how participants use the features and capabilities of the VW.

Participants were each given a unique project requirement explaining the requirements for the Rube Goldberg machine. For example, "Your machine must have at least (3) different components, your machine must have at least (3) different colors or textures, your machine must contain at least (1) circular object." Each team had two weeks to complete the project so that trustfulness and trustworthiness could be measured over time.

We conducted an initial pilot study to test the efficacy of the setting, our measures, and our research design. During the pilot, participants were given the task of developing a project charter. The pilot study revealed that the task was not complex enough; therefore, participants did not use all the VWTCs available to them such as interaction or rendering capabilities. Instead, participants relied primarily on text chat to complete the task. The pilot study highlighted the importance of identifying an appropriate task that would require participants to use all the VWTCs available to them in the three-dimensional environment. As one participant pointed out, VWs are not suited for all task types. For example, attending a lecture in Second Life would not be the most effective use of the technology. Previous studies have identified the nature of a group's task as a variable which plays an important role in group performance (Poole et al., 1985; Shaw, 1981). After carefully reviewing pilot data, we determined that participants needed to build something together. Therefore, we modified the task to require participants to build a machine in Second Life, necessitating participants to utilize more VWTCs.

The task used in the study can be classified as both an intellective task and preference task. Intellective tasks require members to combine their individual efforts and contributions to arrive at the best solution for a given task (Zornoza et al., 2002). Preference task types use judgments or preferences where there is no correct answer. Because of this, social interaction of group members is important so different viewpoints are heard and all members can participate (Huang & Wei, 2000). The task was broken down into four steps, each step requiring separate synchronous meetings (refer Table 2).

*** Add Table 2 here. ***

In summary, each group was provided with the steps for completing the project, the project requirements, and the schedule constraint (two-week completion). No other instructions were given in terms of project goals or desired outcomes.

3.1.2 Participants

To improve the chances of internal and external validity and reduce selection bias, participants for the study were recruited arbitrarily in Second Life and randomly placed into groups. Twenty-five, experienced Second Life users participated in the research. Participants were randomly distributed across 7 groups and had no prior history working together (Group 1 N=2; Group 2 N=4; Group 3 N=5; Group 4 N=3; Group 5 N=3; Group 6 N=4; Group 7 N=4). Groups were limited to four to five members to reduce the difficulties larger teams face in computer-mediated communication environments (Valacich et al., 1992). Groups were formed sequentially throughout the project, as one group finished the next began.

Participants were solicited using channels within Second Life including billboard announcements and postings about the study on VW related websites and forums (e.g., http://www.sluniverse.com, http://forums.secondlife.com, etc.). Due to the synchronous nature of the task, participants were required to meet at the same time, even though they were distributed across various time zones. They were motivated to participate in the project because of their interest in Second Life and they received monetary compensation for their time (6,200 Linden dollars, the equivalent to $25 USD at the time of the study). Participants were paid only on the completion of the project and the survey. Payment was an incentive for staying with the project and dedicating their time to the research. We do not believe that the reward had an impact on the outcome of the study because participants were paid regardless of the outcome of their project. Participant demographics are included in Table 3. Sixty percent of the participants were 43 and older. There are no additional data points to indicate why there were more participants in the 43+ age groups. One possible explanation could be that the solicitations for participants were made on professional billboards, announcements, and websites which are more frequented by business professionals. It could also be that nearly 50% of Second Life users at the time of the study, fell into the age range of 35 years and above (Borst, 2009).

*** Insert Table 3 here. ***

One person on the research team was available during all sessions to answer questions and observe the experiment in progress. Each team participated in four steps (refer Table 2) and each step required one or more synchronous meetings. The researcher was active during step 1 to explain the project. After that the researcher became passive, strictly observing behavior during the remaining steps.

3.2 Data Collection and Measurement

We employed a case study protocol to guide us during data collection. Our protocol included components such as an overview of the project, field procedures, and case study questions as suggested by Yin (Yin, 2009). The overview provided the task information, the original research question, and relevant literature about the constructs being studied. The field procedures consisted of procedures for collecting data, a schedule of data collection activities, and operational details for collecting and archiving the data for later analysis. It also included case study questions to help guide our analysis, e.g., what VWTCs do people use most often, how do people represent themselves in team interactions, how do people use VWTCs to demonstrate trust? These questions helped ensure our analysis was associated with our proposed conceptual model. As a part of the study, we measured **trustfulness, trustworthiness, adaptive use via usage experience, inclusiveness, and fit.** Data was captured from surveys, videos, still images, and text chat. Multiple data sources provided opportunities for triangulation and the unique synthesis of different measures. Analysis of the data occurred *within each case and across cases.*

3.2.1 Measurement

Qualitative and quantitative data was collected at the beginning of the project and during each of the four steps of each team's work and at the end of the task. Quantitative data was collected using a pre-project survey and post-project survey. The surveys were created using questions from previously validated research (survey instrument and related research available upon request). All constructs were measured using multiple items based on a five-point scale.

All group meetings took place in Second Life and each was recorded using video recording software. Still images were captured throughout the project highlighting specific interactions among group members. Communication during each group meeting took place using the text chat feature in Second Life. (In recent years, SL has provided an audio chat feature; this was not enabled during our study). All text chat was stored in a log file that could then be used during data analysis. At the end of each group meeting, researchers created an observation log that documented specific interactions between individuals, specific uses of the technology, and specific comments made by individuals. The qualitative data was used for triangulation, to supplement conclusions and provide further explanation of the findings.

3.2.2 Data Analysis

A triangulation approach was used by examining the statistical data captured from the pre and post surveys (qualitative) while simultaneously considering individual actions and team interactions portrayed in video and still images (quantitative). Individual and team communication captured in the text chat log were also reviewed in relation to the video and still images (quantitative). The various data points were used to observe the events that took place within the VW and used to illustrate the conceptual model. The qualitative data was particularly useful for supplementing, explaining, and illuminating the quantitative data captured from the survey

Explanation building was used to analyze the case data to build an explanation about the actions of each team (Yin, 2009). Replication logic was applied in interpreting the findings across the multiple cases. Each group completed the project using the same research procedures, no changes were made to the research design.

Quantitative data was analyzed using statistical analysis. One-way ANOVA was used to determine if there was a correlation between trustfulness, trustworthiness and the adaptive use of VWTCs. Correlation analyses were run to determine if there were any correlations between the constructs. Qualitative data was analyzed using a triangulation approach by examining the content of text chat logs while simultaneously considering individual and team interactions as portrayed in video, still images and the observation logs. Additionally, the qualitative data was examined in relation to the quantitative data to triangulate the data (true triangulation of data is supported by more than one source of evidence [e.g. Sieber, 1973; Yin, 1982]). The text chat log was analyzed to determine frequency of communication and to identify patterns of discussion. Video and still images were used to observe how team members interacted with each other during the project. The goal was to obtain information about how participants used the technology to interact and communicate. For example, still images revealed that avatars used actual objects to explain their ideas for the Rube Goldberg machine design. When analyzing the video and still images, the following questions were considered – 1) How did people represent themselves in interactions? 2) How did people utilize the technology to convey trustworthiness? trustfulness? 3) How were the technology capabilities used in group interactions? Analysis involved a careful review of the combined data sources to develop a holistic assessment of the findings and identify patterns and offer explanations, this helped provide external and construct validity (Yin, 2009, pp. 40-45).

4.0 RESULTS

4.1 Statistical Analysis

Trustfulness and trustworthiness were each measured at the beginning and the end of the project. There was a magnitude of difference between pre and post means for most groups, of the 7 groups, trustfulness increased in five groups, and trustworthiness increased in six groups (see Table 4).

*** Insert Table 4 here. ***

The differences in the mean levels of trust varied significantly. To verify that there was a significant difference in trustfulness/trustworthiness among the teams, t-tests were conducted. For the two measures of trust, we conducted a paired sample T-test for each group to determine if the mean difference was significant at the .05 and .10 level. Collectively, there was a significant difference at the .05 level (trustfulness p = .021; trustworthiness p = .003). At the group level, a significant difference was found for trustfulness at the .05 level (2 of the 7 groups) and at the .10

level (4 of the 7 groups). A significant difference was also found for trustworthiness at the .05 level (3 of the 7 groups) and at the .10 level (5 of the 7 groups).

There is a strong indication that trust levels changed over time. To understand this change we conducted additional analysis to determine if there was a correlation between trustfulness, trustworthiness, and the adaptive use of VWTCs (measured by fit, inclusiveness, and usage experience). One-way ANOVA tests showed no significance at the .01 or the .05 level between post-task levels of trustfulness/trustworthiness and fit, inclusiveness, and usage experience. Correlation analysis was run to determine if there were any correlations between these constructs. Bivariate correlation showed that usage experience was the only construct shown to have a correlation to trustfulness and trustworthiness (at the .05 level) – fit and inclusiveness did not have a correlation at the .10 or .05 level (See table 5).

*** Insert Table 5 here. ***

4.2 Analysis Across Cases

Seven cases were analyzed for this research. Table 6 reports information on each case study group: a description of their final Rube Goldberg machine and the project outcome. Five of the seven groups met all project requirements (e.g. 3 or more objects, 3 or more textures, 1 circular object, continuous chain of events). Two groups did not meet requirements because their machine did not have a continuous chain of events, there was no chain reaction.

*** Insert Table 6 here. ***

While the statistics do not support a direct causal relationship, the results of both the quantitative and qualitative results indicate potential relationships. The case descriptions reveal interesting findings and patterns for all teams. While the quantitative data reflect that only usage experience was significant, we noted common behaviors across groups.

As per our conceptual model, we wanted to understand how the ***adaptive use*** of ***TCs*** affected trust. We analyzed ***adaptive use*** by exploring the constructs of ***fit***, ***inclusiveness***, and ***usage experience***. ANOVA tests showed that usage experience was the only construct to have a correlation to trustfulness and trustworthiness (at the .05 level) – fit and inclusiveness did not have a correlation at the .01 or .05 level. We analyzed **TCs** by considering the unique TCs offered by VWs and their impact on trustfulness and trustworthiness.

1. Fit. We measured fit based on whether the participants felt the need to repurpose the capabilities or change them from their original intent. TTF theory suggests that "an appropriate task/technology fit should result in higher performing groups (Zigurs & Buckland, 1998, p. 325)". The quantitative results did not show a correlation between fit and trustfulness/trustworthiness. We reviewed the qualitative data carefully to determine if there were differences in the way the groups adapted the technology. This review highlighted some differences in the way participants fit the technology in each group. We found "*participants fit the VWTCs in different ways*." Although individuals did not feel the need to repurpose the VWTCs, they used them in creative ways aimed at supporting the needs of the group. For example, to facilitate discussion and group decision making, a participant in Group 3 set up several objects with different textures and asked everyone to vote on one (Figure 2). This allowed the group to visualize the objects, rather than just discuss them.

*** Insert Figure 2 here.***

To further illustrate how *participants fit VWTCs in different ways,* each group submitted a different form of a design document (required deliverable in Step 2) (Figure 3). Groups used the building capabilities to create their initial design. One group created an image outside of Second Life, imported that image as a texture and shared it with everyone. Another group built a white board to draw their design. Group 6 created a prototype using objects, and another group provided a text-based description using a notecard. While each group had different outputs, the technology provided the capabilities to complete the task requirements.

*** Insert Figure 3 here. ***

2. Inclusiveness is the extent to which someone embraces and utilizes the diverse capabilities provided by the technology. For example, an individual who uses most of the capabilities in a multi-purpose collaboration system would have high inclusiveness levels. High inclusiveness can be affected by the level of media naturalness of a given technology. "Media that incorporates all the elements of unencumbered face-to-face interaction (e.g., physical presence, ability to see and hear others, synchronicity) will be perceived as more natural for communication than other media. (Kock, 2001, p. 12)." Therefore, it is possible that the more natural a medium the more capabilities the user will use which in turn may affect how the user may use specific capabilities. In our study, VWTCs proved to be more natural for communication and coordination because participants did not use other communication mediums available to them like email or voice chat. In the context of this research, the teams that had high inclusiveness scores, met the project requirements. Group 5 had the lowest inclusiveness score, did not meet the project requirements, and experienced a decrease in pre and post trustfulness/trustworthiness. We found that Group 5 used fewer VWTCs for each step in the project and had fewer lines in the text chat log. Group 7 also did not meet the project requirements and had a low inclusiveness score. Although Group 7 experienced a small increase in pre and post trust measures, the group started with high trustfulness/trustworthiness (4.06/4.21) scores. The qualitative and the quantitative findings suggest that participants who used a greater variety of VW technology capabilities to complete the project may experience higher levels of trustfulness/trustworthiness.

3. Usage Experience is the user's perception about their experience using and interacting with the technology. Usage experience was the only construct in adaptive use that had a correlation between post levels of trustfulness and trustworthiness at the .05 level. Participants were asked questions relating to usage experience on the post survey. The questions asked about the individual's perception about the use of capabilities in relation to performance, productivity, effectiveness, and project completion. The group that had the highest increase in trustfulness and trustworthiness also had the highest usage experience score (Group 1, UE=4.37). The group that showed a decrease in pre and post trustfulness and trustfulness had the lowest usage experience score (Group 5, UE=3.5). This group did not meet all requirements, used fewer VWTCs, and had fewer communication items in the text chat log.

4. Technology Capabilities. TCs in relation to virtual worlds can be broadly classified into five categories - awareness, communication, team process, interaction, and rendering. Several commonalities were observed among the groups in the way specific VWTCs were used and how their use affected team performance and trust. Each of the 7 groups in the project had their own individual and team dynamics. There were variations among groups in terms of team interaction and completion of tasks, yet we observed some commonalities. We found that the use of specific VWTCs played a role in team collaboration. Specifically, representation (avatar appearance), non-verbal communication and immediacy of artifacts were notable in team collaboration.

Representation. Avatar appearance was important to individuals in the study. Our data suggests that individuals are concerned with how they are perceived by others when technology is used to represent them. Many participants in the study put considerable effort into their avatar's appearance, often paying money for clothing, gestures, and animations for their avatars. Avatar appearance was also a topic of discussion in casual group conversation. Consider the following excerpts from the text chat logs regarding avatar appearance.

> *Participant1: "well I don't always look like this see haha"*
>
> *Participant2*: *"You said you dressed professionally for the meetings"*
>
> *Participant1: "Yes. For example,): I don't like my "default" avatar look, before I came here I was dressed this way [changing appearance] and you can really do it up here in Second Life. Of course many days I'm an elf or faerie or other things as well.*
>
> *Participant3: "For this project, I will be using my "professional" avatar, Professor X."*

In a VW, individuals can represent themselves as any object, including non-humans. Most participants dressed their avatar professionally, but a few individuals did not. One participant was represented as a centaur and another as a cat. The groups with the centaur (Group 4) and the cat (Group 5) had lower levels of post trustfulness and trustworthiness. Group 5 had both a cat and a person dressed as a night dancer. The video for this group showed that the night dancer avatar was standing away from the group and was not encouraged to participate in the discussion. In the other groups, avatar appearance was a topic of communication, but there were no outliers in terms of appearance. The data suggests a potential relationship between avatar appearance and one's engagement in the shared activities and communication taking place in the virtual space.

Non-Verbal Communication. VWTCs allow users to mimic non-verbal cues in the virtual environment. Types of non-verbal communication in include avatar placement in relation to others, clapping, laughing, and dancing. Avatars can change their gaze and positioning to indicate the direction in which they are looking and can be used to engage others or to direct attention to an item of interest. Avatars also have the option to perform gestures that mimic normal human nonverbal communications. Nonverbal cues played an important role in team dynamics. Consider the following examples. The following text chat exchange took place after one participant avatar accidently collided with another.

> *Participant1: "sorry about that, just ran into you"*
> *Participant2: "LoL, it happens"*
> *Participant3: "In SL you have to adjust to the concept of personal space being different"*
> *Participant3: "people sometimes can't help it lol"*
> *Participant2: "yes...but that shows how pervasive VWs can be...that we feel compelled to apologize when our pixels connect"*

In another example, an avatar's nonverbal communication affected another's communication style. During the initial meeting for Group 4, an avatar was wearing a watch. The facilitator was providing many textual details about the project to the group. The facilitator noticed the avatar look at his watch several times throughout the meeting. Inferring on nonverbal cues in face-to-face communication, the facilitator associated this behavior with loss of interest. Not having met the avatar before, the facilitator felt the avatar was bored and thus changed her communication style to engage participants in the conversation. In another scenario, nonverbal communication may have contributed to lower group collaboration. In Group 5, there was one avatar who did not interact with others in the group. This avatar was distanced from the group, held her hands behind her back, and did not convey any other emotion. This avatar was short with her responses and did not participate in collaborative building efforts. During one of the meetings, another participant in that group approached the research observer in a private chat and asked if this avatar was planted on the team as a control mechanism.

Participant 1: "I want to ask you if anyone in the group is a 'plant' lol"

Project Sponsor: "ha ha, nope."

*Participant 1: "I'm asking because, I *think* that the way Participant2 was behaving or at least the way I perceived her to be…it was off putting at first. I'm not shy at all and Participant3 seems arty and funny."*

Participant 1: "Basically, Participant 2 is a bit combative or at least appears that way."

Participant 1: "In fact, I became friends with Participant 3, but didn't even think to offer it to Participant 2."

Participant 1: "I thought perhaps Participant 2 was 'planted' to cause a wall.

Participant 1: "It is very interesting how one person can affect a whole group."

These examples highlight the significance of non-verbal communication in team interaction.

Immediacy of Artifacts. Immediacy of artifacts is the ability to construct visual artifacts in the form of text, images, pictures, three-dimensional pictures, three-dimensional models, or some combination thereof in real time (c*itation removed for peer review*). Immediacy of artifacts allowed participants to quickly build artifacts to show which skills they had to complete the project. Team members frequently leveraged this capability, building objects in an ad hoc way to demonstrate how things could work in their Rube Goldberg machine. Once someone had built an artifact, these objects frequently became the center of attention. They were eager to show others their objects and talk about their ideas. This generated more discussion (more items in the text chat log) and collaboration among participants.

5.0 DISCUSSION

The objective of this study was to explore via a case study analysis how technology capabilities affect trust in virtual teams. The overarching research question, *How does the use of technology capabilities afforded by virtual worlds affect the development of trust in virtual teams?* and the associated *conceptual model* (Figure 1) served as the basis for our analysis. We will discuss the major findings related to this question and generate propositions for future research.

The 7 cases portray how VWTCs can be used in a virtual team. But did the use of VWTCs affect trust? The current study explored this question by examining video, still images, text chat logs, and observation notes of groups with various levels of trust obtained through questionnaire data. The research was viewed through a socio-technical lens to highlight the interdependencies between the social aspects of work and technology. We have grouped our findings into three areas, each discussed next.

Adaptive Use of Technology Capabilities in Virtual Teams

Prior research on VWs found that the interplay between the social and technical components can affect team processes and project outcomes (*citation removed for peer review*). In our study, trustfulness trustworthiness, and adaptive use represent the social components while the technical components are the task and the use of VWTCs. Our findings suggest that these social and technical components work together to create a desired outcome. Consistent with task-technology fit (TTF) theory, participants *fit* the VWTCs in different ways. TTF theory maintains that an appropriate task/technology fit results in higher performing teams (Goodhue & Thompson, 1995). Groups used VWTCs in creative ways aimed at supporting the needs of the group such as using three-dimensional objects for brainstorming, prototyping and discussion. The findings are consistent with Adaptive Structruation Theory (AST) which posits that the way the technology is used to perform specific tasks can affect team processes within a team. In their study of GDSSs (Desanctis & Poole, 1994), the same technology was introduced to two groups, however, the effects were not consistent due to differences in each group's appropriation moves. In our study each group had access to the same VWTCs, however, groups used technology in different ways. For example, Group 5 had 1 member who attempted to direct others and was not succesful with regard to team engagement and communication. In this case, that avatar was represented by a cat, rather than a human avatar. Finally, the study suggests a correlation between trust and usage experience, which is the user's experience with using and interacting with technologies (Yu, et al., 2011). Those teams that had a higher usage experience also showed an increase in trustfulness/trustworthiness. The concept of usage experience is based on the Technology Acceptance Model (TAM) and the premise is that the acceptance of the technology will influence usage experience of the technology. In summary, participants used VWTCs in different ways to complete each step of the project, and more VWTCs were used for the steps that were more complex. The blend of communication and unique VWTCs allowed participants to create artifacts to supplement their communication (e.g. voting boxes, white board) to provide a powerful communication synergy that affects overall levels of trust. We also found that potential unequal work distribution (e.g. Group 5) and low communication leads to low adaptive use and low trustfulness and trustworthiness. Based on our initial research model and the data analysis, we conclude the following in relation to VWTCs and trustfulness/trustworthiness.

> ***Proposition 1****: VWTCs provide opportunities for collaboration and communication leading to high adaptive use of VWTCs which affects individual trustfulness and trustworthiness.*

Virtual World Technology Capabilities

Another objective of our research was to explore how specific *technology capabilities afforded by virtual worlds affect the development of trust in virtual teams.* The review of qualitative data in conjunction with the quantitative data highlighted some interesting patterns that are worthy of exploration. Most interesting is the way specific VWTCs were used and its impact on team performance. Three major findings can be abstracted from our analysis. First, we found representation (avatar appearance) was significant. In face-to-face communication, individual appearance is important in trust development (Lea & Spears, 1995). In VTs, the effects of individual appearance are lost. However, how one represents him/herself online is important – whether it is through avatars, individual photos, or images. The way individuals represented themselves in the digital space via their avatar appearance was a major discussion topic in many groups. Other research on embodied social presence (ESP theory) states that an embodied representation, such as an avatar, affects the perceptions of individuals by drawing them into a higher level of cognitive engagement in their shared activities and communication acts (Mennecke, 2011). An embodied presence creates an opportunity for the individual to develop and extend their identity in the virtual environment and to create an identity for themselves, identify with others, and promote the development of trust (Mennecke, 2011). While we did not find direct evidence to suggest a tie between avatar appearance and engagement, we did find that one's perception of another's embodied representation is important. For example, certain participants in the study spent considerable effort customizing their avatar, however that did not increase their overall engagement on the team. Instead, it potentially had negative impact on trust and in this case swift trust was at work. Meyerson et al. (1996) maintains that in swift trust, members make categorical judgments of others based on stereotypes. Given that there were certain participants that did not conform to traditional stereotypes, this may have affected their ability to develop that swift trust. Whether in a two-dimensional or three-dimensional space, online personas are important. Consider LinkedIn profile pictures, someone's first impressions from a photograph are likely to stick, even after you meet in-person (Gunaydin, et al., 2016). Future research might look at how online personas affect initial trust levels. Thus, we offer the following proposition:

> ***Proposition 2****: The embodied representation of an individual in a virtual space can affect the perception of trustworthiness of that individual.*

Second, non-verbal communication played a critical role in enhancing communication within the group. Nonverbal cues are central to the communication of trust (Walther & Tidwell, 1995; Kasper-Fuehrer & Ashkanasy, 2001). Prior research suggests that visual cues, physical appearance, posture, gestures, body movements, and nonverbal cues can be used in the development of trust (Lea & Spears, 1995; Bacharach & Gambetta, 1997; Hung et al., 2004). While physical touch can’t be replicated, other factors can be available to VTs when using the capabilities offered in a virtual world. The 7 groups intentionally used non-verbal communication cues which may be an important factor for team collaboration and developing trust. In Group 5, one of the avatars was positioned away from the others, stood with her hands behind her back, and as a result was not engaged in the team activities. Her behavior suggested that she was not interested in participating. On the other hand, Group 3 used non-verbal communication in the form of dancing and laughing and their team had the highest increase in trust levels. Therefore, we propose:

> ***Proposition 3****: The ability to display non-verbal cues in a virtual space can affect the development of trustfulness and trustworthiness.*

Finally, the ability to showcase one's skills and abilities (immediacy of artifacts) was helpful for building trust and team collaboration. Immediacy of artifacts is the ability to construct visual artifacts in the form of text, images, pictures, three-dimensional pictures, three-dimensional models, or some combination thereof in real time (Davis et al., 2009). Developing artifacts helps people identify with others which may be helpful for promoting empathic attitudes that build trust (Hung et al., 2004). In our study, participants frequently leveraged this capability, building objects in an ad hoc way to demonstrate how things could work in their Rube Goldberg machine. They were eager to show others their objects and talk about their ideas. Once someone had built an artifact, that object frequently became the center of attention and this generated more discussion (more items in the text chat log). Groups that had fewer artifacts in their workspace had a less collaborative work environment. Groups that had more items in their workspace had a more collaborative environment. These findings suggest that the ability to immediately create artifacts to illustrate, conceptualize and share one's ideas could be an important feature for the development of trust and team collaboration. We propose the following:

> ***Proposition 4****: Individual trustfulness and trustworthiness are positively influenced by the immediacy of artifacts in a virtual space.*

Trust in Virtual Teams

Can VWTCs truly facilitate the development of trust in VTs? Trustfulness and trustworthiness increased during the study for 5 of the 7 groups. Two groups started with higher levels of trustfulness/trustworthiness (> 4.00). Both teams experienced a small increase in trustworthiness and one team experienced a small increase in trustfulness and the other had a small decrease. This suggests that participants joined the team with high levels of trust which could be related to high personality-based trust or institution-based trust. One group started with a relatively low level of trust (2.89/2.75) but trustfulness/trustworthiness increased significantly. This suggests that the participants came to the team with already low levels of trust and through the project increased their trust levels. The remaining teams started with moderate levels of trust (>3.0 and <3.8) and had varying degrees of changes between pre and post survey levels. We did not measure the impact of personality-based trust or institution-based trust. We also did not consider the influence of culture. However, the results suggest that these factors are important to initial trust, but, it is not clear how the initial level of trust affected the development of trust throughout the project. Therefore, we propose:

> ***Proposition 5:*** *Initial individual trustfulness and trustworthiness may influence the development of trust in VTs.*

In summary, the results of our study suggest that specific VWTCs do affect the development of trust in virtual teams. While participants use the technology in various ways, what is important is how the technology affects the social aspects of team collaboration.

6.0 Limitations, Implications, and Future Research

6.1 Limitations

As with most research of this kind, there are limitations that warrant mention before discussing implications. Because of the exploratory nature of the research, there was not enough data to develop a theory or specific conclusions. We did not measure the impact of personality-based trust or institution-based trust, but our data suggests that these factors play a role in initial trust levels. While participants did not belong to a common institution; one could argue that Second Life acted as the common institution and members of Second Life have certain norms and rules that are followed by participants. The study was designed to measure trust over time (longitudinal), 2 weeks may not be enough time for full trust development. We also did not have any controls in place for exogenous variables that may influence the study results. For example, we did not control how much time was spent by each team to build their project other than 2 weeks, nor did we control how many VWTCs were used. Finally, the study did not consider how national and personal cultural differences could potentially affect trust.

6.2 Theoretical and Practical Implications and Future Research

VW technology capabilities (VWTCs) allow users the ability to mimic physical characteristics and actions of the real world. In our study, communication, rendering, and interaction capabilities allowed participants to use technology to evaluate trustworthiness and assess individual capabilities. Next generation collaboration technologies could adopt facets of VWTCs so individual users can use three-dimensional spaces with customized avatars as their embodied representation, to develop a higher level of cognitive engagement in their shared activities and communication acts with others. While this paper answers some questions about how VWTCs can help develop trust in VTs, it also raises many questions. We provide a model for further work on this topic and encourage researchers to investigate other social and behavioral issues faced by VTs in a VW setting. There are opportunities for further exploration of the interrelationships between fit, inclusiveness, usage experience and trustfulness/trustworthiness and additional evidence is needed to fully support or oppose the propositions presented. We know that over time trust will develop in VTs to match the same levels as face-to-face teams (Wilson et al., 2006). VWTCs provide an opportunity for trust to develop more quickly or even go beyond trust levels in face-to-face teams. Future research might measure levels of personality-based trust, institution-based trust, and cultural dispersion to clarify the external factors that affect the development of trustfulness and trustworthiness. There is indirect evidence to suggest that avatar appearance, nonverbal cues, and immediacy of artifacts affects trustfulness/trustworthiness. We need to understand how these unique VWTCs specifically affect the development of trust.

6.3 Conclusion

In summary, our research study suggests that TCs can affect trust in VTs and identifies specific VWTCs that are important in virtual team collaboration. These TCs can be further studied to understand how they may be used to enhance future collaboration tools which foster an environment of trust. Our goal was not to recommend a specific technology platform, but rather explore how unique TCs impact behaviors in VTs. The study identified interesting findings relating to how people use TCs to complete tasks and collaborate on a team. These findings may be used to help develop guidelines and recommendations for using technology to enhance work practices in VTs.

References

Adman, P., & Warren, L. (2000). Participatory sociotechnical design of organizations and information systems – an adaptation of ethics methodology. Journal of Information Technology, 15(1), 39-51.

Anantatmula, V. S., Kanungo, S. (2010). Modeling enablers for successful KM implementation, *Journal of Knowledge Management*, 14(1), pp.100-113.

Bacharach, M. & Gambetta, D. (1997). Trust in Signs. In Cook, K.S. (ed.). Trust in Society. Russell Sage Foundation. New York. 148–184.

Bell, M. W. and Robbins-Bell, S. (2008). Toward an Expanded Definition of “Virtual Worlds". New Digital Media: Audiovisual, Games and Music. Rio de Janeiro: e-papers.

Bharadwaj, A. S. (2000). A Resource-Based Perspective on Information Technology Capability and Team Performance, MIS Quarterly, 24(1), 169-196.

Bhattacharya, R., Devinney, T. M., and Pillutla, M. M. (1998) Academy of Management Review, 1998, 23(3), 459-471.

Borst, T. (2009). Know your customers: Second Life demographics. Virtual World Business. Retrieved November 14, 2009 from http://virtualworldbusiness.com/2009/04/30/know-your-customers-second-life-demographics.

Bostrom, R. P., & Heinen, J. S. (1977). MIS problems and failures: A socio-technical perspective. MIS Quarterly, 1(3), 17-32.

Breuer, C., Hüffmeier, J., & Hertel, G. (2016). Does trust matter more in virtual teams? A meta-analysis of trust and team effectiveness considering virtuality and documentation as moderators. Journal of Applied Psychology, 101(8), 1151-1177. http://dx.doi.org/10.1037/apl0000113

Burton-Jones, A., and Straub, D.W. (2006). "Reconceptualizing System Usage: An Approach and Empirical Test," Information Systems Research (17:3) 2006, pp 228-246.

Carlson, J.R., and Zmud, R.W. (1999). "Channel expansion theory and the experiential nature of media richness perceptions," *The academy of Management Journal* (42:2), pp 153-170.

Cascio, W. F. (2000). Managing a virtual workplace, Academy of Management Executive, 14(3), 81-90.

Chen, C., Wu, J., Meng, M., and Michael, K. (2011). Enhancing virtual team performance: A leadership perspective, *Human Systems Management*, 30(4), pp. 215-228.

Chou, L., Wang, A., Wang, T., Huang, M., and Cheng. B. (2008). Shared work values and team member effectiveness: The mediation of trustfulness and trustworthiness, Human Relations, 61(12), 1713-1742.

Daft, R.L., and Lengel, R.H. (1984)." Information richness: a new approach to managerial behavior and organizational design," in: *Research in organizational behavior* L.L. Cummings and B.M. Staw (eds.), JAI Press, Homewood, IL, pp. 191-233.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and end user acceptance of information technology, MIS Quarterly, 13(3), 319-340.

Davis, A., Murphy, J., Owens, D., Khazanchi, D., & Zigurs, I. (2009). Avatars, people, and virtual worlds: Foundations for research in metaverses. Journal of the Association for Information Systems, 10(2), 1-29.

DeSanctis, G., & Poole, M. S. (1994). Technology use: Adaptive structuration theory. Organization Science, 5, 121-147.

Dennis, A.R., Fuller, R.M., and Valacich, J.S. (2008) "Media, tasks, and communication processes: A theory of media synchronicity," *MIS Quarterly* (32:3), pp 575-600.

Denton, D. K. (2012). Let me make this clear: creating high trust organizations, *Development and Learning in Organizations: An International Journal*, 26(3), pp.19-21.

Goodhue, DD, Thompson, R. (1995). Task-technology fit and individual performance, MIS Quarterly 19(2).

Gunaydin, G., Selcuk, E., and Zayas, V. (2016). Impressions based on a portrait predict, 1-Month later, impressions following a live interaction, *Social Psychological and Personality Science*, 8(1).

Hakonen, M. and Lipponen, J. (2009). It takes two to tango: The close interplay between trust and identification in predicting virtual team effectiveness, The Journal of eWorking, 3(1), 17-32

Henttonen, K., and Blomqvist, K. (2005). Managing distance in a global virtual team: the evolution of trust through technology-mediated relational communication, Strategic Change, 14, 107-119.

Herbsleb, J. D., Mockus, A., Finholt, T., & Grinter, R. E. (2000) Distance, dependencies, and delays in a global collaboration, Proceedings of Computer Supported Cooperative Work 2000, New York: ACM.

Holste, J. S., and Fields, D. (2010). Trust and tacit knowledge sharing and use, *Journal of Knowledge Management*, 14(1), pp.128-140.

Huang, W. W. and Wei, K. K. (2000). An Empirical Investigation of the Effects of Group Support Systems (GSS) and Task Type on Group Interactions from an Influence Perspective, Journal of Management Information Systems, 2000, 181-206.

Hung, Y. T. C, Dennis, A. R. and Robert Jr., L. P. (2004). Trust in Virtual Teams: Towards an Integrative Model of Trust Formation, HICSS, 2004.

Jarvenpaa, S. L, Knoll, K., and Leidner, D. E. (1998). Is Anybody Out There? Antecedents of Trust in Global Virtual Teams, Journal of Management Information Systems, 14, 4, 29-64.

Jarvenpaa, S. L., Shaw, T. R., and Staples. D. S. (2004). Toward Contextualized Theories of Trust: The Role of Trust in Global Virtual Teams, Information Systems Research, 14(3), 250-267.

Judd, C. M., Smith, E. R., and Kidder, L. H. (1991). Research Methods in Social Relations (6th ed.), Fort Worth, TX: Saunders College Publishing.

Kasper-Fuehrer, E. C., and Ashkanasy, N. M. (2001). Communicating trustworthiness and building trust in interorganizational virtual organizations, Journal of Management, 27, 235-254.

Lamb, R., & Kling, R. (2003). Reconceptualizing users as social actors in information systems research. MIS Quarterly, 27(2), 197-235.

Lea, M. & Spears, R. (1995). Love at First Byte? Building Personal Relationships Over Computer Networks, in Wood, Julia T. and Duck, Steve (eds.). 1995. Under-Studied Relationships. Off the Beaten Track, Thousand Oaks: Sage Publications.

Majchrzak, A., Rice, R. E., Malhotra, A., King, N. & Ba, S. (2000). Technology Adaptation: The Case of a Computer Supported inter-Organizational Virtual Team, MIS Quarterly, 24(4), 569-600.

Malhotra, A., Majchrzak, Ann, and Rosen, B. (2007). Leading Virtual Teams, *Academy of Management Perspectives*, 21(1), pp. 60-70.

Mayer, R.C., Davis, J. H., and Schoorman, F. D. (1995). An Integrative model of organizational trust, Academy of Management Review, 20, 3 (1995), pp. 709-734.

McAllister, D. J. (1995). Affect- and cognition-based trust as foundations for interpersonal cooperation in organizations, Academy of Management Journal, 1995, 38, 24-59.

McGrath, J. E. (1984). Groups: Interaction and performance. Englewood Cliffs, NJ: Prentice-Hall.

Mennecke, B. (2011). An Examination of a Theory of Embodied Social Presence in Virtual Worlds, Decision Sciences Journal, 42(2), 413-450.

Meyerson, D., Weick, K.E., & Kramer, R.M. (1996). Swift Trust and Temporary Groups. In R.M. Kramer & T.R. Tyler (Eds.), Trust in Organizations: Frontiers of Theory and Research: 166-195. Thousand Oaks, CA: Sage Publications.

Mitchell, A., Zigurs, I. (2009). Trust in virtual teams: solved or still a mystery?, *the DATABASE for Advances in Information Systems*, (40,3), pp 61-83.

Mulligan, P. (2002). Specification of a capability-based IT classification framework, Information & Management, 39, 647-658.

Peters, L. M., and Manz, C. C. (2007). Identifying antecedents of virtual team collaboration, *Team Performance Management: An International Journal*, 13 (3/4), pp. 117-129.

Poole, M. S., Siebold, D. R. and McPhee, R. D. (1985). Group Decision-Making as a Structurational Process, Quarterly Journal of Speech, 1985, 74-102.

Sarker, S., Valacich, J.S. and Sarker, S. (2003), “Virtual team trust: instrument development and validation in an IS educational environment”, Information Resources Management Journal, Vol. 16 No. 2, pp. 35-55.

Shaw, M. E. (1981). Group Dynamics: The Psychology of Small Group Behavior, McGraw-Hill Book Company, New York, 1981.

Sieber, S. D. (1973). The integration of fieldwork and survey methods, American Journal of Sociology. 7(8), 1335- 1359.

Steuer, J. (1992). Defining Virtual Reality: Dimensions Determining Telepresence, *Journal of Communication,* 42(4).

Sun, H. and Zhang, P. (2008). Adaptive System Use; An Investigation at the System Feature Level, Twenty Ninth International Conference on Information Systems, Paris 2008, 1-17.

Valacich, J., Dennis, A. R., and Nunamaker, A. F. Jr. (1992). Group size and anonymity effects on computer-mediated idea generation. Small Group Research, 23(1), 40–73.

Walther, J. B., and Tidwell, L.C. (1995). Nonverbal cues in computer-mediated communication, and the effect of chronemics on relational communication, Journal of Organizational Computing, 5(4), 355-378.

Wilson, J. M. Straus, S. G. and McEvily, B. (2006). All in due time: The development of trust in computer-mediated and face-to-face teams, Organizational Behavior and Human Decision Processes, 99, 16-33.

Yin, R. (1982). Studying phenomenon and context across sites. American Behavioral Scientist, 26, 84-100.

Yin. R. (2009). Case study research: Design and methods (4th ed.). Thousand Oaks, CA: Sage.

Yin, R. (2012). Applications of Case Study Research (3rd ed.). Thousand Oaks, CA:

Yu, X., Owens, D., Arora, V., & Khazanchi, D. (2011). From IT Artifact to IT Capabilities: A Conceptual Exploration, Working paper, University of Nebraska at Omaha.

Zigurs, I. (2003). Leadership in virtual teams: Oxymoron or opportunity?" *Organizational Dynamics*, 31(4), 339-51.

Zigurs, I. and B. K. Buckland (1998). A theory of task/technology fit and group support systems effectiveness, MIS Quarterly (22) 3, 313-334.

Zigurs, I., and Munkvold, B.E. "Collaboration technologies, tasks, and contexts," in: *Human-computer Interaction and Management Information Systems: Applications,* I.B. Dennis F. Galletta, Ping Zhang (ed.), M.E. Sharpe, 2006.

Zornoza, A., Ripoll, P. and Peiro, J. M. (2002). Conflict Management in Groups that Work in Two Different Contexts: Face-to-Face and Computer-Mediated Communication, Small Group Research, 2002, 481-508.

Tables and Figures.

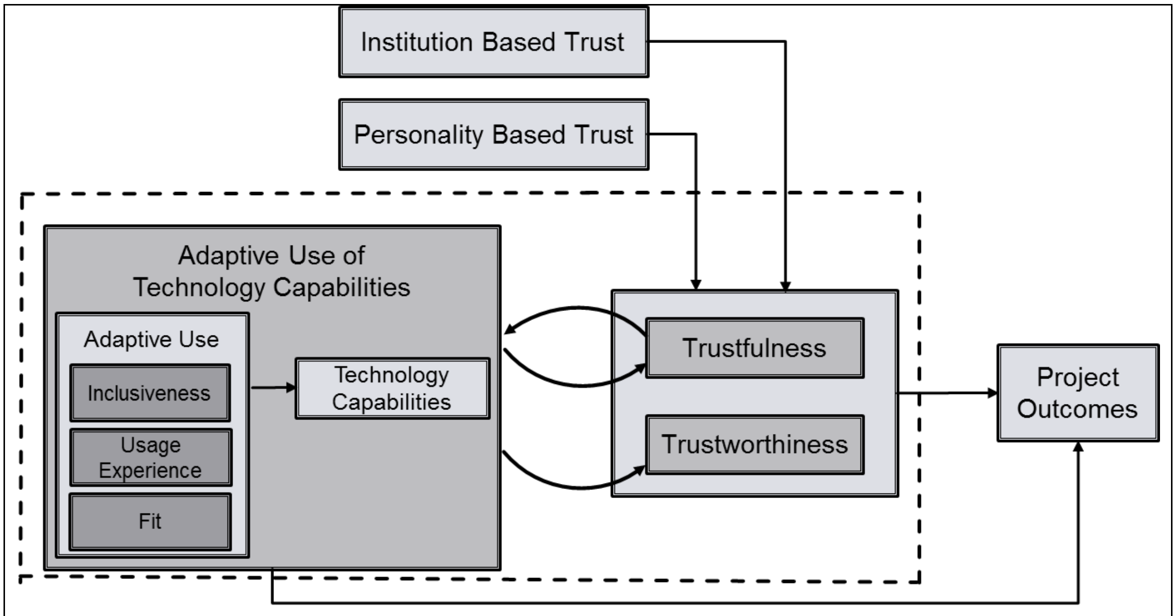
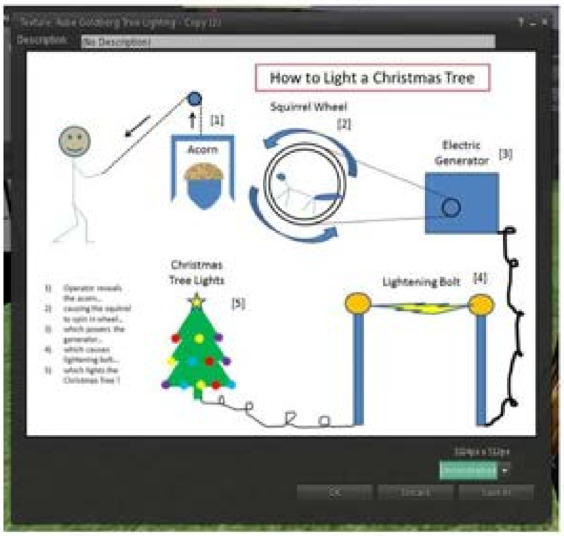


Figure 1. Conceptual Model

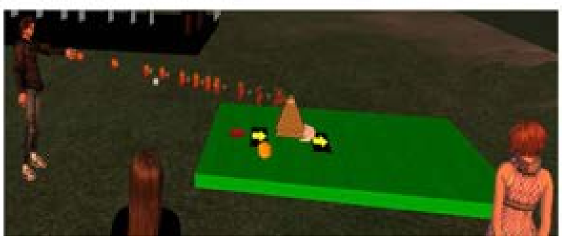
Figure 2. Voting on Textures

Group 2 imported an image as a texture and the texture was shared with everyone in the group.



Group 5 created a white board to draw their design. When finished they took a picture of the white board.

Group 6 created a mini-model of their machine using the objects and textures available in Second Life.



Group 7 described their design on a notecard and then shared the notecard with everyone in the group.

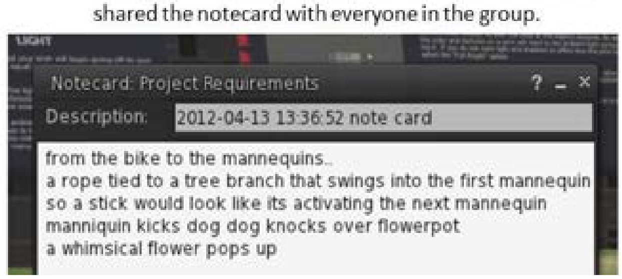


Figure 3. Various Design Documents

Table 1. Technology Capabilities in relation to Virtual Worlds	
Category	**Definition/Examples**
Awareness	Capabilities that allow users to participate synchronously and provide a sense of being present within a virtual space *Examples: Avatar presence; Instant Messaging*
Communication	Capabilities that support communication and collaboration. Such communication capabilities should be able to: a) ***provide communication channels*** (Zigurs & Munkvold, 2006); b) support high quality of communication by ***increasing the speed of message delivery*** (Dennis et al. 2008) and ***supporting the transmission of multiple cues*** (*citation removed for peer review*); and c) ***provide channel expansion capability*** which allows users to expand their understanding of technology characteristics as they interact with the technologies (Carlson et al. 1999). *Examples Instant Messaging; Voice Chat; Note cards; Gestures (non-verbal communication); Avatar Presence (non-verbal communication)*
Interaction	Capabilities that support direct interactions between people or between people and artifacts. Interaction capabilities might include real time interaction such as interactivity, mobility, and immediacy of artifacts (an ability to construct visual artifacts in the form of text, images, pictures, three-dimensional pictures, three-dimensional models, or some combination thereof in real time). *Examples: Interactivity through building and scripting; Avatar mobility; Object mobility*
Rendering	Capabilities the support "the process of creating or executing life-like images on the screen" (*citation removed for peer review*). Personalization and vividness are two capabilities that constitute capabilities for rendering. ***Personalization*** allows people to create personal focus among people (Daft et al. 1984), and ***vividness*** allows a mediated environment containing rich information in terms of formal features (Steuer, 1992). *Examples: Avatar presence; Building and scripting; Object rendering*
Team Process	Capabilities that provide support for process structuring, enable information processing, provide appropriation support, and enable socialization and community building. ***Process structuring*** is defined as "any aspect of the technology that supports, enhances, or defines the process by which groups interact" Information processing is defined as the capability to gather, share, aggregate, structure, or evaluate information (Zigurs et al. 1998), such as brainstorming tools. ***Appropriation support*** refers to the support for appropriation provided by restrictiveness of the technology and outside factors (Dennis et al. 2008). *Examples: Community building using groups and islands*

Table 2: Task Descriptions	
Steps	**Description**
Step 1 – Meet and Greet	Participants participated in a 30-minute meeting to meet their team members. Participants were provided with instructions to complete the project, the project scope statement, and required deliverables.
Step 2 – Machine Design	Groups were required to create a design specification for their machine. Groups were instructed to deliver a single document describing the details and specifications of their machine. Teams were only given high level instructions for the design document and suggestions such as "should include a description of the various components and may even include a diagram of the machine."
Step 3 – Build Machine	Groups worked together to build the "Rube Goldberg" machine according to their design specifications. This step took place over 1 or more meetings.
Step 4 – Operating Instructions	Groups were instructed to provide operating instructions for their machine so visitors would know how to operate the machine.

Table 3. Demographic Information			
Gender	Male	10	40%
	Female	15	60%
Age	18-26	1	4%
	25-33	4	16%
	34-42	5	20%
	43-51	6	24%
	52 or older	9	36%

Table 4. Statistical Means for Pre and Post Trustfulness and Trustworthiness						
Group	**Trustfulness**			**Trustworthiness**		
	Pre	**Post**	**Diff.**	**Pre**	**Post**	**Diff.**
Group 1 N=2	2.89	4.50	1.61	2.75	5.00	2.25
Group 2 N=4	3.67	4.08	0.41	3.54	4.17	0.63
Group 3 N=5	3.47	4.27	0.8	3.67	4.73	1.06
Group 4 N=3	4.41	4.33	-0.08	4.78	4.89	0.11
Group 5 N=3	3.37	3.19	-0.18	3.44	3.33	-0.11
Group 6 N=4	3.64	4.33	0.69	3.71	4.72	1.01
Group 7 N=4	4.06	4.58	0.52	4.21	4.96	0.75

Table 5. Correlations between Trustfulness, Trustworthiness, Fit, Inclusiveness, and Usage Experience

N=24		Trustfulness Post Mean	Trust-worthiness Post Mean	Fit Post Mean	Inclusive-ness Post Mean	Usage Experience Post Mean
Post Trustfulness Mean	Pearson Correlation	1	.893**	.240	.147	**.429***
	Sig. (2-tailed)		.000	.258	.492	.037
Post Trustworthiness Mean	Pearson Correlation	.893**	1	.126	.265	**.430***
	Sig. (2-tailed)	.000		.557	.212	.036

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Team #	Table 6: Machine Descriptions Rube Goldberg Machine Description	Project Result
1	4 components Ball rolls down a ramp, hits a domino. Dominoes fall and move a bar which raises a flag up the flagpole.	Met all requirements
2	6 components Avatar runs in a wheel, generates a spark of electricity which drops a ball down a compartment. The ball hits a domino. Dominoes fall and close a switch lighting a Christmas tree.	Met all requirements
3	6 components A cannon shoots a ball into the air landing on a platform. The ball rolls down the platform and hits a rock with a flower. Atop the flower is a bee. The Bee starts buzzing and moves a ball down a ramp which hits a boot. The boot hits a toaster which pops out a piece of toast.	Met all requirements
4	3 components A door opens, hitting a domino. Dominoes fall, hitting a lamp illuminating the lamp.	Met all requirements
5	4 components A palm tree drops a coconut. A surf board raises and lowers. A balloon inflates and pops sending particles in the air.	Did not meet all requirements. Machine did not have a continuous chain of events after the initial interaction. Each component had to be touched by the avatar to cause an action.
6	6 components An avatar sits on a bicycle and pedals. The pedals start a windmill and the windmill blows a mannequin. The mannequin moves another mannequin which starts a dog running in a circle. The dog knocks over a pail of water, causing a flower to grow out of the ground.	Met all requirements
7	6 components A ball rolls into a pyramid and shoots out the top of the pyramid. The ball shoots in the air to a ramp and rolls down the ramp and hits a windmill. The windmill begins turning and hits a domino. Dominoes fall hitting a panda bear. The panda bear throws the ball into a basketball hoop.	Did not meet all requirements. Machine did not have a continuous chain of events after the initial interaction. Each component had to be touched by the avatar to cause an action.