(To appear in the ***International Journal of Project Organisation and Management***)

Attitudes towards Face-To-Face Meetings in Virtual Engineering Teams: Perceptions from a Survey of Defense Projects

*Lawrence R. Blenke**

*Abhijit Gosavi (Corresponding Author)***

*William Daughton****

*2345 Crystal Drive
Suite 1000
Arlington, Virginia 22202

Email: lrblenke@gmail.com

**219 Engineering Management Building

Missouri University of Science and Technology, Rolla, MO 65409

Phone: (573)341-4624; Email: gosavia@mst.edu

*** College of Engineering & Applied Science, University of Colorado at Colorado Springs, 1420 Austin Bluffs Pkwy, Colorado Springs, CO 80918

Email: wdaughto@uccs.edu

Abstract: Modes of communication used in *virtual* defense projects have changed dramatically over the years with tools such as email and video-conferencing dominating face-to-face (FTF) meetings. We conducted a survey at a defense firm with an aim to test current attitudes towards FTF meetings – with respect to significant problems faced, project success, transfer of technical requirements, preference for FTF vis-à-vis virtual meetings, differences between virtual and co-located environments, criticality of various forms of communication, and whether FTF meetings were scheduled as often as desired. Our survey participants, about one hundred in number, were experienced engineers, technicians, and program managers – working in a virtual product development team at a defense firm. The results suggest that despite significant advances in virtual communication technologies, FTF meetings remain critical and cannot be eliminated from defense firms. Further, it is also clear that FTF meetings can play a significant role in reducing chances of miscommunication.

Keywords: Virtual Teams; Face-to-Face Communication; Likert Surveys

1. Introduction

Increasing use of technology and automation has changed how projects are conceptualized, executed, and managed. Technology has started playing an important role in how communication occurs, and has led to project teams that are *virtual*, i.e., not all members are located in the same location, rather they are geographically dispersed. In many cases, these team members may even be located in different countries (Gibson and Cohen, 2003). While there are many advantages to having a virtual team, which we will discuss later, an obvious downside is that face-to-face (FTF) communication among team members becomes limited.

Consider a scenario in which a project manager is placed in charge of leading a virtual team. A number of decisions that the manager must make revolve around the following issues: How useful/productive are virtual meetings in comparison to their FTF counterparts? How often should FTF meetings be scheduled? What are the critically important forms of communication? This paper conducts a survey of a defense firm to explore answers to key issues surrounding FTF vis-à-vis virtual communications.

Defense firms are increasingly engaging in what are often called local virtual teams, which do not involve international members. On the other hand, global virtual engineering teams involve members in different countries (see Hosseini and Chileshe (2013) and references therein). Many virtual projects in the U.S., especially those in the defense sector, do not involve international team members; yet their members are dispersed in different parts of the country. Due to the associated costs and difficulties in concentrating a large multi-functional employee base at each site, corporations are now running large engineering development projects across multiple divisions separated by distances; see Lee-Kelley and Sankey (2008) and references therein. For instance, it is not uncommon for a defense-based firm to have only a few members in New York City, where office space is expensive, but many other members in cities like Buffalo, NY, where technical work is conducted, and others in Colorado Springs, CO and Tampa, FL, where direct testing of the product is possible. Fortunately, Information Technology (IT) has greatly improved within the last decade due to the internet and the increased bandwidth of telecommunication tools, which has greatly simplified work needed in defense projects. As this technological advancement accelerates, it is becoming more and more unlikely in the future that all project team members of a defense project will be located at a single site.

In general, project managers are nowadays required to develop an understanding of virtual communications, e.g., via email, even when managing collocated teams. But in virtual projects, this understanding has to occur at a level and detail that projects with co-located teams do not require. Most virtual projects are not run entirely virtually; a number of FTF meetings are also scheduled – during the course of the project. Of course, in the globalized setting, because of the significant costs involved, FTF meetings may be quite infrequent. Nonetheless, even in teams where all members are located within the same country, FTF meetings are not very common. Because of reduced FTF communication that co-located teams can take advantage of, virtual projects are in greater risks of failure due to communication deficits (Daim et al., 2012). Managers of virtual projects are required to have an in-depth understanding of the implications of scheduling FTF meetings and the issues related.

Literature review: Rapid recent advances in communication infrastructure are allowing more and more companies to seek virtual development in their operations. A more up-to-date definition of virtual teams, which incorporates the impact of technology, is : “virtual teams are groups of workers with unique skills, who often reside in different geographical places and who have to use

means of information and communication technologies for cooperation, in order to span the boundaries of time and distance" (Kirkman and Mathieu, 2004). Thus, in a virtual project, team members are not co-located; rather they are located within different cities, and they tend to communicate via email, video-conferencing, telephones, and electronic media to accomplish goals. Considering the numerous advances that have occurred in communication technologies in recent years, virtual teams form the next logical step in the evolution of organizational structure – with over 8.4 million employees becoming members of one or more virtual groups (Aubert and Kelsey, 2003).

Unfortunately in many instances, the success of these teams, in terms of project efficiency and stakeholder satisfaction, has not improved as dramatically. In particular, questions have even been raised about how successful virtual portions of projects are – given that most virtual projects are hybrid and contain some virtual elements and some non-virtual (Bajer, 2007). One reason for this inconsistency is that even though the tools for virtual team communication may be available across the sites, there are non-technological factors that do not transfer across the internet as easily (Burgoon et al., 2002). Unlike in co-located teams, subtle, yet important, cues are easily missed in a virtual environment (Pauleen and Yoong, 2001). Once a web conference has been terminated, the same follow up that happens in the hallways or by the water coolers of the offices co-located team members work in is unlikely to occur in a virtual setting, and a valuable communication opportunity is lost. This kind of a misstep can occur at both peer-to-peer level and the manager-to-report level. Moreover, the subtle non-verbal facets of communication, such as body language, can be missed, or worse misinterpreted, when team members never meet in person to develop personal relationships (Burgoon et al., 2002).

A recurring theme in the area of virtual team management is the need for trust to be developed between team members and the project management (Mitchell and Zigurs, 2009). There are a myriad of aspects to virtual team management, and much research identifies communication and trust across the team as the primary enablers for success (Jarvenpaa et al. 2004). While there are many methods of improving communication and trust in both co-located and virtual development teams, one area that is considered a given in the former and an exception to the rule in the latter is face-to-face (FTF) interaction, i.e., in-person interaction. In an FTF meeting or interaction, communicating members are in the same location speaking to each other. A vast majority of papers state there is no better method of communication than FTF communication (MacDonnell et al., 2009). It is also said to be the "most effective precursor" for establishing a solid foundation for excellent communication throughout the project (Daim et al., 2012).

FTF communication is synchronous, which provides for continuous discussions, whereas virtual communication is often asynchronous – resulting in disjointed discussions. FTF communication also allows for instantaneous feedback and give-and-take, which is often not possible across electronic media (Peters and Manz, 2007); further, it allows for removal of any misunderstanding that can arise. This issue, when combined with the hesitancy to respond with "permanent" records, typically associated with email and electronic communication technology, explains why FTF discussions result in better feedback than electronic dialogue.

There is a general consensus throughout the literature that some level of FTF contact is necessary – although opinions differ regarding *when* it should take place. Cascio and Shurygailo (2008) recommend that when a team is set up, key team members should meet at a kick-off meeting to allow interpersonal relationships to form. Lee-Kelley and Sankey (2008) prefer a broader and more inclusive approach which also includes non-key members. An interesting

example of the value of extended FTF meetings, despite their significant cost, is given by Kezsbom and Edward (2000) in the context of the development of the Boeing 777 aircraft. The relationships formed by an extended interaction, such as the one facilitated by Boeing that ran for eighteen months, allowed the participants to develop contextual knowledge of the other group members (D'Souza and Colarelli, 2010). Knowing the context within which other team members are communicating clarifies the information transfer and lowers misconceptions that can form in geographically distributed teams. Contextual knowledge is intuitively shared by co-located teams via FTF discussions, direct meetings and hallway conversations. This ancillary transfer of understanding is difficult in virtual teams. An example is provided by De Pillis and Furumo (2006): "When a (virtual) team member does not attend a meeting due to a local holiday, other team members can link this to laziness which can cause conflict and difficulties between team members." In a co-located setting, there would be a common understanding of local traditions and more frequent communication to avoid this type of misinterpretation. We must note that we found one reference (Bjorn and Ngwenyama, 2009), which suggested that FTF communication may actually be counterproductive at times; much of the literature suggests that FTF meetings are useful on the whole. It is well-known that a communication breakdown increases project risks related to failure to meet deadlines and exceeding budgets as well as in performance deficits in meeting customer's requirements/specifications (see Boehm (1991), Olsson (2007), Anderson et al., (2007), DeMarco and Lister (2003), and Wallace and Keil (2004)).

Contributions of this paper: A body of literature exists on problems faced in virtual teaming. The text edited by Gibson and Cohen (2003) provides a review on numerous aspects of how to make virtual teams work; see also Begley (2004) for a textbook account. Hertel et al. (2005) review empirical research in virtual teaming. Purvanova and Bono (2009) discuss leadership issues, while Paul et al. (2009) study conflict management. Montoya et al. (2009) study issues on the intersection of social dynamics and media limitations in new product development. Mancini (2010) and Greenberg et al. (2007) consider trust issues within virtual teams. Fiol and O'Connor (2005) study hybrid teams in addition to purely virtual and purely co-located teams. A subset of this literature treats the topic for software/IT projects – many of these teams tend to be of a global nature. See Andres (2002), Henttonen and Blomqvist (2005), Reed and Knight (2010), Daim et al., (2012), and Iorio et al., (2012) for a subset of some excellent past work that deal with communication breakdown and virtual projects. The last three look at global virtual teams, while the first surveys professionals from the IT industry. To the best of our knowledge, a critical gap in the literature is with respect to issues related to virtual teaming specifically in the *defense industry*. Unlike software/IT projects, the defense industry is typically involved in developing military technologies and products that have a physical nature and are required to function in warfare. Defense industries produce UAVs that have software as well as hardware components, which have to be tested for functionality. As such, the nature of the work involved makes defense-related projects quite distinct from database-software-building virtual projects. Further, some communication cannot be conducted via virtual methods due to confidentiality and safety. Hence, virtual teams in the defense industry are typically not global but have the different sites within the same country.

This research seeks to present, to the best of our knowledge, for the first time, a survey of team members of virtual projects in the defense industry. The goal is to take a critical look at various aspects of virtual teams in such a setting. In particular, we seek to study the following five major research questions:

(i) What is the most important problem faced in a virtual team in a defense engineering project?

(ii) FTF meetings: In this day and age of advanced communication technologies, are FTF meetings still necessary in defense projects? If yes, is there a preference for FTF vis-à-vis virtual communication and whether there is a relationship between this preference and familiarity with technology? Further if FTF meetings are necessary, how frequent should they be and when should they be scheduled?

(iii) What are the major forms of communication in a virtual meeting in a defense project? How imperative are these different forms?

(iv) Virtual vs co-located defense teams: Are there any differences in the quality of communication in a virtual team versus the same in a co-located team? Is there a significant risk of transfer of information via virtual communication than there is in co-located teams?

(v) Are the virtual components of (hybrid) defense projects successful?

The survey was designed to provide answers to the questions posed above. Some of the main ideas that we seek to cover via the survey are presented in Figure 1. Our overall goal is to provide a comprehensive analysis of the perception of team members to the above-described traits of virtual teaming and practices. It is our hope here that the results and analysis of this survey will provide guidance to members and senior project managers involved in virtual teams in defense industries. The insights are also likely to be of use in general for many other industries that employ virtual teams.

The rest of this paper is organized as follows. Section 2 discusses the research methodology we used and also provides information related to the educational background and experience of the survey's respondents. Section 3 presents the main questions in the survey and analyzes the responses; it concludes with policy recommendations that may be of interest in practice. Section 4 concludes the paper with comments on potential future work.

2. Research Methodology

The survey was given to about 100 employees in an aero-space-defense corporation. Data was collected from six different sites that included St. Louis (MO), Merrimack (NH), Dayton (OH), Buffalo (NY), Gaithersburg (MD), and Ft. Walton Beach (FL). Products developed at these sites included UAVs, military training systems, electronic warfare systems, avionics and communication equipment. All the participants of the survey were members of virtual teams. Some basic questions related to the background of the respondents revealed that about 75% of them had more than eight years of experience in their engineering field. About 60.2% of the employees belonged to the baby boomer generation, while 24.1% belonged to Generation X and 13.9% belonged to Generation Y (or the millennial generation born after 1980). The remainder belonged

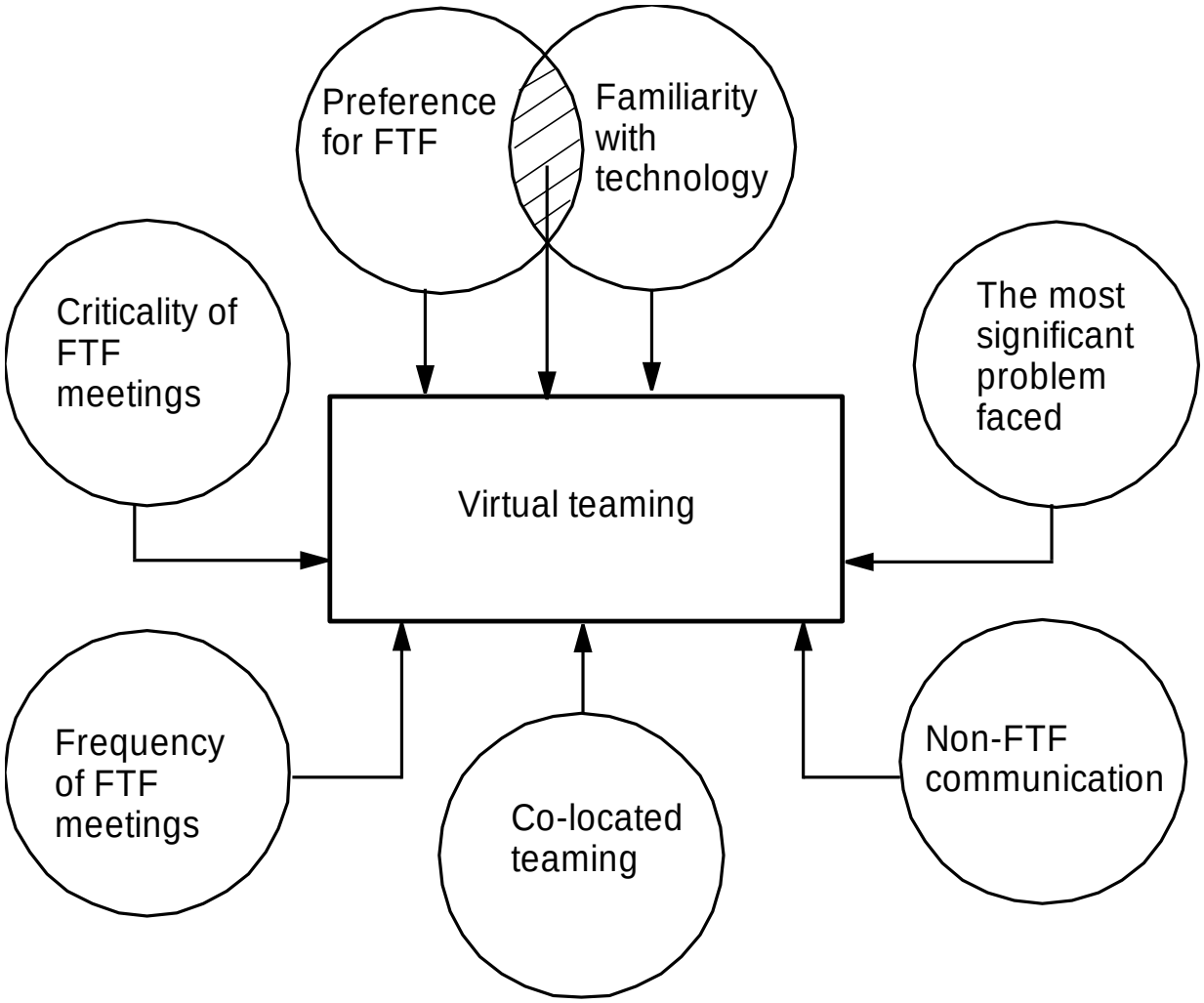

Figure 1: A schematic showing the issues explored in our survey

to the silent generation. About 32.4% of the respondents were hardware engineers, meaning there were either mechanical or electrical engineers, 19.8% of the engineers were systems engineers, 13.5% were software engineers, and 14.4% were project engineers. The remaining respondents belonged to areas not listed above and were called program support personnel. This profile is quite typical of many aerospace-defense firms that the first author has interacted with. Many of the survey questions used a Likert scale. The analysis of responses was performed using a binomial approximation that allowed the computation of *p*-values the details of which are provided below. For some questions that had categorical responses a Pearson's chi-squared test (Johnson and Bhattacharya, 2010) was used.

Analysis of responses from the Likert scale: Responses obtained via the Likert scale were analyzed as follows. The binomial distribution was exploited to develop a test of statistical significance for categorical data. The respondents who agreed and strongly agreed were combined into one group, called Group 1, while the respondents who disagreed and strongly disagreed were combined into another group, called Group 2. The neutral responses will be combined with either of the two groups (explained below). This leads to the response assuming the binomial distribution,

used for measuring proportions of populations, which can be approximated by the normal distribution (Johnson and Bhattacharya, 2010).

Let p_i denote the estimated proportion of population that belongs to Group *i*, and G_i denote the number that belongs to the *i*th group. Let *n* denote the total number of respondents. Then, the estimated proportion of the *i*th group should satisfy the following:

$$p_i = \frac{G_i}{n}.$$

The margin of error can be computed via the normal approximation to the binomial distribution. The standard error for the binomial distribution is then given by $\sqrt{\frac{p_i(1-p_i)}{n}}$ while the 100(1-α) % margin of error is given by $100.z_{\alpha/2}\sqrt{\frac{p_i(1-p_i)}{n}}$. This yields the following confidence interval in % terms for p_i:

$$100.\left(p_i - z_{\alpha/2}\sqrt{\frac{p_i(1-p_i)}{n}}, p_i + z_{\alpha/2}\sqrt{\frac{p_i(1-p_i)}{n}}\right).$$

An important question that arises here is: What should be done with the neutral responses? First, combine the neutral responses with Group 1. Without loss of generality, let us assume that $G_1 > G_2$. The hypothesis we wish to test then will be:

H_0: $p_1 \leq p_2$ versus H_1: $p_1 > p_2$

For a given value of α, compute the confidence intervals for p_1 and p_2. Determine if the confidence intervals overlap. If they do not overlap, then combine the neutral responses with Group 2. Check if the following holds again: $G_1 > G_2$. If yes, re-compute the confidence intervals to determine if the same result is obtained, i.e., the confidence intervals do not overlap. When the same result is obtained on both occasions, we can reject the null hypothesis.

In the above, if (i) the confidence intervals overlap on one occasion but not on the other, or if (ii) they overlap on both occasions, or if (iii) $G_1 \leq G_2$ when the neutral responses are combined with G2, we cannot reject the null hypothesis.

3. Analysis of Survey

This section is devoted to an analysis of the results of our survey, which is followed by policy recommendations for managers of virtual teams. We have divided this section into seven subsections, where each of the first six sub-sections covers a different aspect of FTF and virtual communication; the last subsection presents the policy recommendations. The first four sub-sections are aimed at discovering the most significant problem faced in a virtual team, uncovering any potential preference for FTF communication, understanding which forms of communication are critical/important, and gaining a better understanding of how useful FTF meetings are – whether they are scheduled as often as needed and the best time to schedule them. The fifth and sixth subsections are related to comparing aspects of communication issues in virtual versus co-located teams and any potential impact of communication on project success respectively.

3.1. The most significant problem faced: To set the stage for our research, we begin by analyzing one of the key questions that rises to the fore:

Question 1: *What was the most significant problem you have experienced with being in a virtual team?*

Five classes of problems were identified as potential responses to this question: (1) The technology utilized, (2) insufficient communication between virtual team members, (3) miscommunication between team members, (4) issues of trust among virtual team members, and (5) Other (indicating a problem other than the ones identified above). The results are shown in Figure 2; a Pearson's chi-squared test was conducted to determine whether each class of problems was equally likely (discrete uniform distribution). The test rejected the null hypothesis with a *p*-value less than 0.001 – indicating that insufficient communication between virtual members, which was the response from 36.7% of the respondents, was statistically the most significant problem. In a sense, this sets the stage for our research. Many of the questions in the remainder of the survey are directly or indirectly tied to FTF communication.

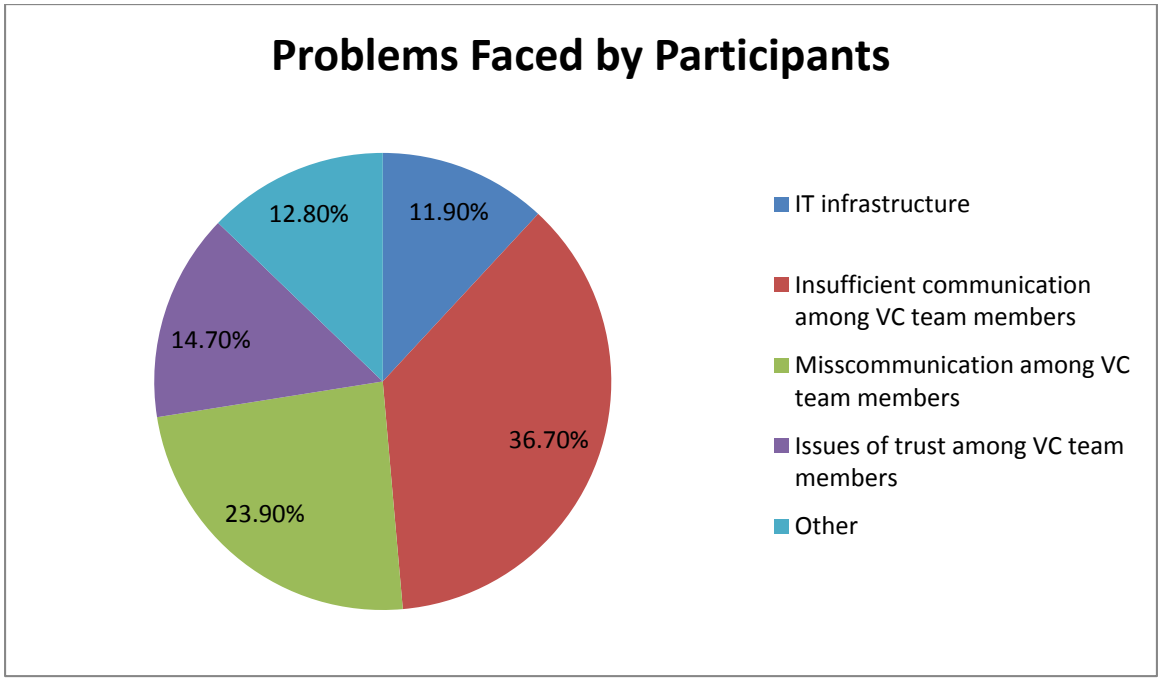

Figure 2: The most significant problem faced by experienced virtual team members

3.2. Preference for FTF communication: Naturally, an important question that arises here is whether there is a preference for FTF communication, and if such a preference does exist, whether it is a result of lack of familiarity with the technology used in virtual communications. Two questions were designed to this end:

Question 2: *What is your level of comfort with virtual communications compared to FTF communications?*

Question 3: *What is your level of expertise with the technology used in virtual communications?*

Responses to Question 2 are shown in Figure 3. Responses to those who preferred and strongly preferred FTF communication were combined into one response, while the remaining responses were combined into the other group. Then, a binomial distribution was used to determine if there was a statistical majority. The test indicated that a statistical majority of 61.5%, with a margin of error of 9.14% when $\alpha = 0.05$ and a *p*-value less than 0.001, preferred or strongly preferred FTF communication. Responses to Question 3 indicated that a statistical majority of 84.55 %, with a margin of error of 6.76% and a *p*-value less than 0.001, were either moderately or extensively familiar with the technology or were experts at using the technology. Clearly, thus, a preference to FTF communication does exist, but it appears that it cannot be attributed to lack of expertise with the technology used. Hence, we decided to explore this issue further.

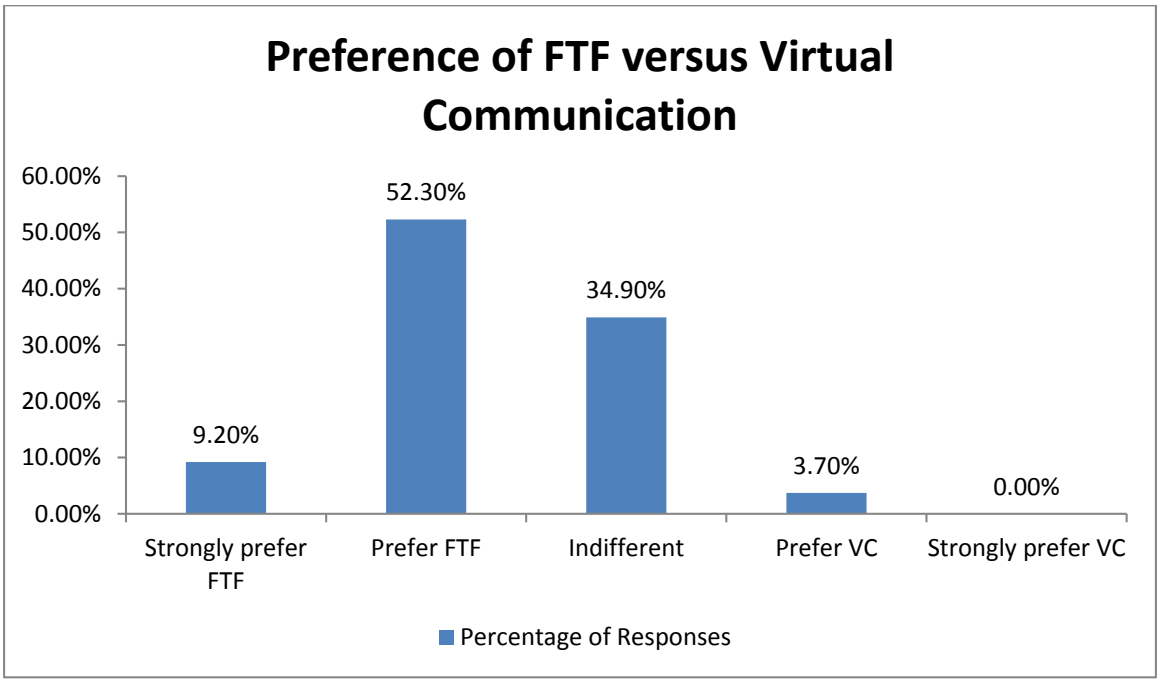

Figure 3: The responses for the level of preference to virtual communication (VC) vis-à-vis FTF communication

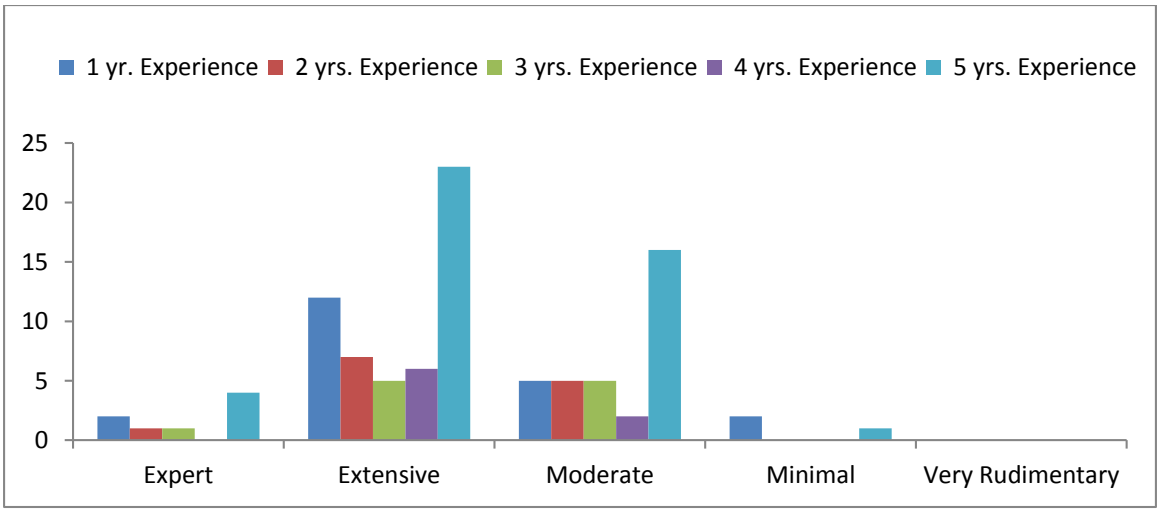

Figure 4: The responses for the level of comfort in virtual communication with respect to FTF and number of years of experience with virtual communication

We performed a cross-sectional analysis of the responses for the level of comfort in virtual communication with respect to the number of years of experience with virtual communication. See Figure 4. The analysis indicates that even when the number of years of experience in the VC increases from one to five, the level of comfort with this form of communication hovers around moderate and extensive levels. Thus, an increase in the number of years of experience does not appear to improve the comfort level of using virtual communication. Further, we analyze the responses of these issues vis-à-vis the number of years employees have been using virtual communication. See Table 1. We perform this comparison to determine if a specific pattern emerges with the use of virtual communication for a long period of time (up to five years). A majority of respondents with five years of experience claim insufficient communication and miscommunication between team members to be the major issue. But this pattern is true regardless of the number of years of experience with virtual communication. Thus, an increase in number of years of virtual experience does not appear to resolve the problems that exist for beginners.

Table 1: The number of responses for issues with virtual communication (VC) and number of years of experience

The number of years of experience in VC	*The technology utilized (IT infrastructure)*	*Insufficient communication between virtual team members*	*Miscommunication between virtual team members*	*Issues of trust among virtual team members*	*Other*
1	2	8	7	3	2
2	3	8	0	0	2
3	2	3	4	1	1
4	0	3	3	0	2
5	4	14	10	11	5

3.3 Criticality of information passed in various forms of communication: Six different forms in which communication typically occurs in a virtual team were identified: FTF, web-conference with minimal verbal response, web-video-conference with full participation, telephone calls, emails, and FTP file transfer/share point. Out of these, the last five are forms of virtual communication. Respondents were asked to rate the criticality of each form of communication using any one of the following options: Critical, Important, Some Value, Questionable Value, and Worthless. Respondents could mark multiple forms of communication in any of those categories. Responses to each form were analyzed separately. Responses in the category "critical" and "important" were combined under the title "imperative." Responses that did not fall in the "imperative" category were considered to be "non-imperative" A statistical majority indicated that all but one form of communication, web-conference with minimal participation, were imperative. Detailed results of our analysis are presented in Figure 5, where each bar represents the fraction of respondents who considered that form of communication to be imperative. Our results suggest that most forms of virtual communication, except for web-conferencing, are considered to be imperative by a clear majority of the respondents and clearly need to be continued with. The highlight of our finding was that FTF and emails were two of the highest ranked forms of information communication. Web-conferences, with minimal and full participation, were ranked at the bottom – indicating that these forms of communication need significant improvement in order to be considered on par with other forms of communication.

3.4 Usefulness, frequency, and scheduling of FTF meetings: A question of some import that emerges in this day and age of advanced communication technologies is: Are FTF meetings necessary? To address this issue, we asked two questions in our survey:

Question 4a: *Were FTF interactions/meetings helpful?*
Question 4b: *Would communications have benefited from more FTF meetings?*
A statistically significant majority of 74.1% (with a *p*-value less than 0.001 and a margin of error of 8.56% at $\alpha = 0.05$) either agreed or strongly agreed with the notion that FTF interactions were helpful. Further, a statistically significant majority of 67% agreed or strongly agreed (with a *p*-value less than 0.001 and a margin of error of 7.25% at $\alpha = 0.05$) that additional FTF meetings would have helped communications. This indicates that FTF meetings are not only indispensable, but are needed more frequently.

Question 5: *At what point in the project would FTF meetings be most helpful?*

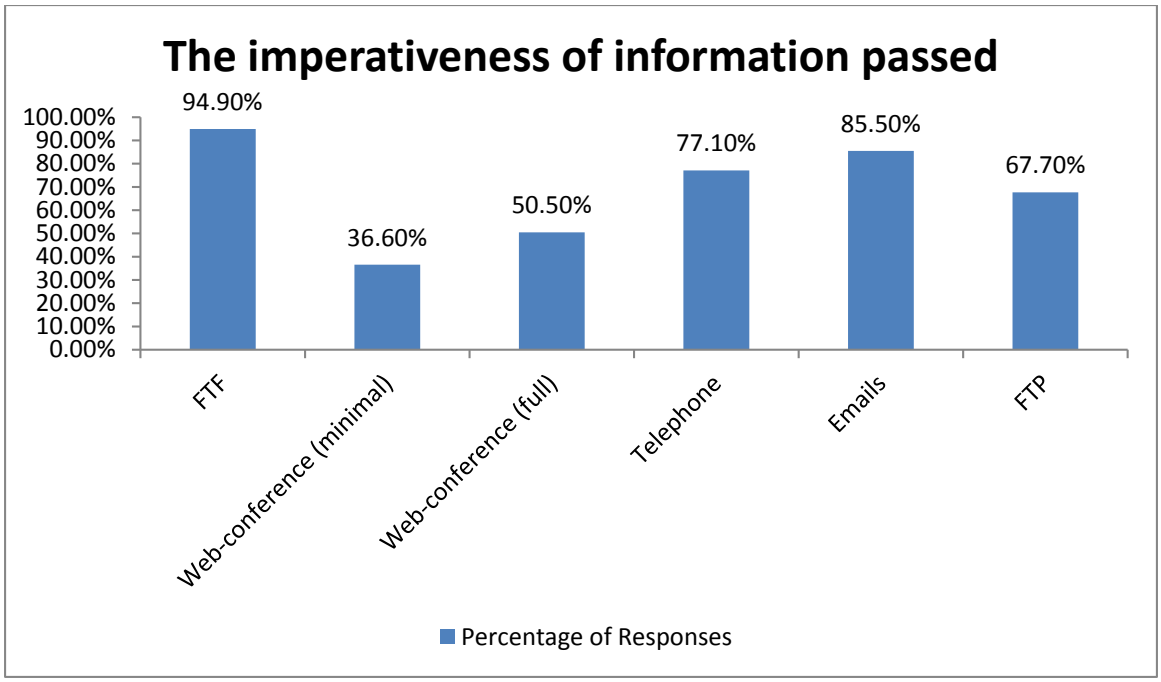

Figure 5: Percentage of respondents who felt that a given form of communication was imperative

Generally, the kickoff meeting tends to be an FTF meeting in many projects. The question is how useful are FTF meetings scheduled thereafter. Four potential *phases*, or time windows, in the project were identified during which FTF meetings can be scheduled: Award to Kickoff, Kickoff to Preliminary Design Review (PDR), PDR to Conceptual Design Review (CDR), and Integration and Test. A Pearson's chi-squared test (for categorical data) indicated that the preferences are *not* equally likely for the four time windows – with a p-value of 0.035. Statistically, the highest preference (37.5%) for FTF meetings is for the time window is between Kickoff and PDR, and this suggests that this time interval deserves special attention when FTF meetings are scheduled.

3.5 Virtual versus co-located: An important goal of this survey was to study differences between virtual and co-located teams in terms of communication. The following questions were directed at uncovering any differences in communication between virtual and co-located teams.

Question 6: Virtual communication resulted in more miscommunication than regular communication in co-located teams.

Question 7: Did you communicate with your virtual team members at least as often as your co-located team members?

Question 8: The transfer of technical requirements across the virtual team was better than in co-located teams.

67% of the respondents, who formed a statistical majority (with a *p*-value less than 0.001 and a margin of error of 9.22% at $\alpha = 0.05$) either agreed or strongly agreed that virtual communication resulted in more miscommunication than regular communication in co-located teams (Q 6). This

clearly indicates that means must be devised to reduce the probability of miscommunication in virtual teams.

A statistical majority of 69.38% (with a *p*-value less than 0.001 and a margin of error of 9.13% at $\alpha = 0.05$) of the respondents indicated that they interacted more with co-located team members than with virtual team members (Q 7). While this is, perhaps, only to be expected, given the fact that co-located team members can communicate with each other with less effort, responses to the previous question indicate that steps taken to reduce the frequency of miscommunication within virtual teams can help improve communication within virtual teams.

A statistical majority of 66.67% (with a p-value less than 0.001 and margin of error of 9.29% at $\alpha = 0.05$) disagreed or strongly disagreed with the notion that transfer of technical requirements was better in virtual teams (Q 8). Clearly, thus, transfer of technical requirements was better in co-located teams, which has implications for managers of virtual projects. This could also be a potential reason for the preference, seen above, for FTF meetings that occur more frequently in co-located teams.

3.6. Project success: Measuring project performance, even creativity (Zhang et al., 2013), is an important research topic. Further, there are tools to estimate the cost of a project (Lipke et al., 2009). In our survey, we sought to measure project success via three criteria: ability to satisfy customer's specifications, meet project deadline (self-imposed or that of the customer), and complete the project within budget. The first of these three objectives is often the most critical. We were interested in determining whether virtual portions of projects are successful in helping develop a working relationship with distant team members. To this end, we designed four questions:

Question 9: The virtual portion of the project was successful in meeting *technical specifications* imposed by the customer.

Question 10: The virtual portion of the project was successful in meeting project *schedule.*

Question 11: The virtual portion of the project was successful in meeting project *budget*.

Question 12: The virtual portion of the project was successful in developing a *working relationship* with distant team members.

Responses to each question above did not yield a statistically significant result – indicating that the virtual portion of the project was not more or less likely to be successful in meeting technical specifications/meeting project budget/meeting schedule or in developing working relationships between distant members. Results are shown in Fig 6. Except in the case of technical specifications, a significant number of neutral observers and a somewhat uniform distribution of responses possibly cause this lack of statistical significance. Even for the case of technical specifications, when the neutral responses are combined with the disagree/strongly disagree responses, the agree/strongly agree responses amount to 57.1% which do not form a statistical majority at $\alpha = 0.05$; the margin of error is 9.74% and the *p*-value is 0.104. For the other cases, the *p*-values are much larger. The above results indicate that the virtual portion of the project can become a significant impediment in the success of a defense project.

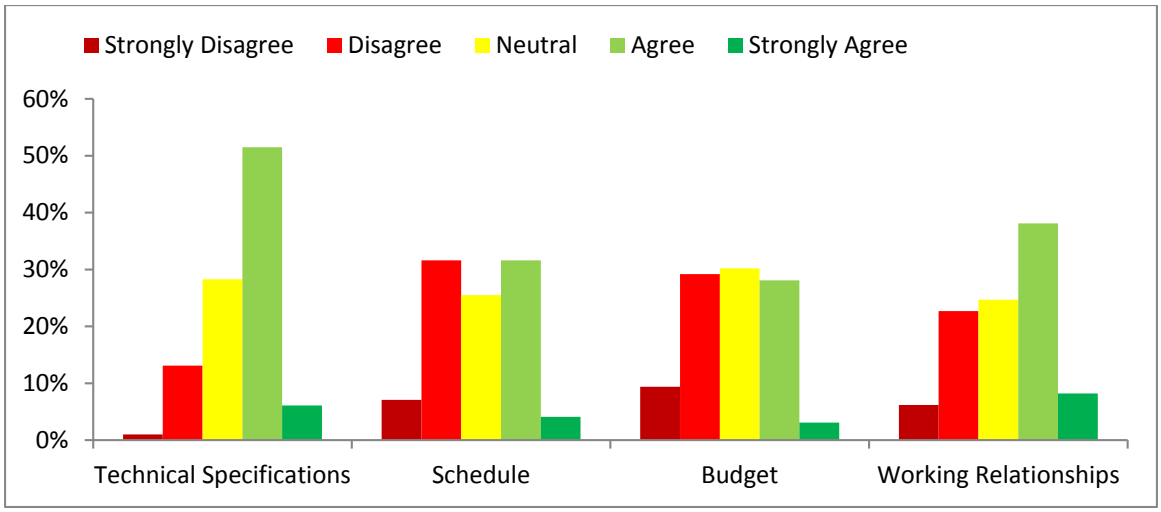

Figure 6: Success of virtual portion of the project with respect to technical specifications, schedule, budget, and working relationships

3.7 Policy recommendations/implications: We now present some of the key observations from our analysis that have practical significance and should be useful to project managers. Overall, the results of this survey suggest that despite advances in video communication technologies, FTF communication remains necessary for avoiding risks to the project from communication deficits. In other words, FTF communication cannot be eliminated from the picture; rather, our analysis suggests that FTF meetings need to become *more frequent* that usual – even if they are expensive. Also, a majority of respondents appears to favor significant FTF communication *during the early phases of the project* – implying that project managers must arrange for FTF meetings during the early stages.

FTF communication was also the *preferred* model of communication, and familiarity with technologies did not seem to impact this preference. Thus, enhanced training or improving familiarity with the communication technologies is not likely to change this perception nor is it likely to enable the project manager to reduce the frequency of expensive FTF meetings.

Further, the imperativeness of various forms of communication was studied. The survey's results show that FTF communication and emails to be *imperative* forms of communication, while video conferencing with minimal participation turned out to be the least imperative form. FTP and web-conferences with full participation were in the middle of the pack. This offers an important insight into the minds of these project members and a key recommendation is to improve the satisfaction rates of web-conferencing. Also, that virtual communication resulted in more miscommunication that regular communication in co-located teams is an overwhelmingly strong feeling. Hence mechanisms that can reduce the probability of miscommunication must be identified and vigorously pursued. The literature indicates that facilitators (Iorio et al., 2012) and other communication practices such as adhering to various verbal protocols such as synchronized communication (Daim et al., 2012) can play a significant role in minimizing miscommunication in virtual projects. This survey is limited to one firm, and firms very different from the one we

surveyed may have uniquely different communication traits. Hence, our policy recommendations should be considered carefully before being applied.

Future of FTF meetings: The means of communication used in industry have been changing rapidly in the last few years. Emails and texting have given way to FTF exchanges and voice mails. For a recent example, consider the fact that Coca-Cola has disconnected voicemails in its headquarters (Stanford, 2014). Indeed, the millennial generation is more comfortable with virtual communication than is any of the older generations. In a few years, the (senior) positions currently held by baby boomers are likely to go to Generation X, which is somewhere in the middle of the baby boomers and the millennials – when it comes to the usage of technology, according to a recent Pew Research survey (Taylor and Gao, 2014). Therefore, it is unlikely that there will be radical changes in the coming years in regards to attitudes to FTF meetings. However, about two decades from now (or perhaps sooner than that), the millennials will become the senior members in a project team. At that point, it is quite possible that FTF meetings will not be viewed to be as important as they are today, and it will be interesting then to determine if FTF meetings are still critical for communication. However, because millennials are unlikely to take over senior management in the immediate future, our findings suggest that FTF meetings will likely remain critical for a few more years. Nonetheless, technology forecasting is a hazardous activity and many famous forecasts have failed, as illustrated well in Pogue (2012). Therefore, we must caution the reader that what we state above in the context of the future of FTF communication may never become a reality.

4. **Conclusions**

The main aim in this study, which is based on a dissertation, was to study attitudes towards FTF meetings in a virtual project within a defense firm. We used a survey at a defense firm and obtained about 100 responses. The survey asked the respondents numerous questions about virtual projects, especially in the context of FTF communication, to study risks arising from miscommunication. The survey also looked at the most important problem faced in virtual teams, which forms of communication are considered imperative by team members, and whether virtual and co-located teams have differences in miscommunication. The main finding from our work is that for defense projects, even in this age of evolved video-conferencing and virtual communication, FTF communication remains a catalyst for reducing risk of miscommunication in virtual teaming. In other words, although expensive, FTF communication needs to be an important part of the communication equation – particularly, in the earlier phases of a project. The strong preference for FTF communication did not seem to have been impacted by comfort with technology.

Future research: Our work opens the avenue for further research in at least two directions. First, the lack of clear evidence on success or failure of the virtual components of projects indicates that virtual teaming within defense projects needs to be closely examined from the perspective of communication. In particular, out of the numerous reasons that have been cited in the literature as factors for miscommunication, lack of trust/interpersonal relations and technology issues, and leadership could potentially cause miscommunication in defense projects and require a detailed survey. Second, responses to our survey revealed a clear lack of preference for virtual communications vis-à-vis FTF communication; while exploring the reasons for this was beyond the scope of this research, this can form the basis for future surveys and analysis.

References

Anderson, A.H., R. Meewan, J. Bal, and J. Carletta. 2007. Virtual team meetings: an analysis of communication and context. Computers in Human Behavior, 23(5), 2558-2580.

Andres, H. P. 2002. A comparison of face-to-face and virtual software development teams. Team Performance Management, 8, 39-48.

Aubert, B. A., and B. L. Kelsey. 2003. Further understanding of trust and performance in virtual teams. Small Group Research, 34(5), 575-618.

Baker, E.H. 2007. When teams fail: the virtual distance challenge. Strategy + Business, May 22, Online, http://www.strategy-business.com/article/li00026?pg=all

Begley, K. A. 2004. Face to Face Communication: Making Human Connections in a Technology-Driven World. Crisp Learning Press.

Bjorn, P., and O. Ngwenyama. 2009. Virtual team collaboration: building shared meaning, resolving breakdowns, and creating translucense. Information Systems Journal, 19, 227-253.

Burgoon, J. K., J. A. Bonito, A. Ramirez, N. E. Dunbar, K. Kam, and J. Fischer. 2002. Testing the interactivity principle: Effects of mediation, propinquity, and verbal and nonverbal modalities in interpersonal interaction. Journal of Communication, 52(3), 657-677.

Cascio, W.F., and S. Shurygailo. 2008. E-Leadership and Virtual Teams, Engineering Management Review, IEEE , 36(1), 79-80.

D'Souza, G. C., and S. M. Colarelli. 2010. Team member selection decisions for virtual versus face-to-face teams. Computers in Human Behavior, 26(4), 630-635.

Daim, T.U., A. Ha, S. Reutiman, B. Hughes, U. Pathak, W. Bynum, and A. Bhatla. 2012. Exploring the communication breakdown in global virtual teams. International Journal of Project Management, 30, 199-212.

DeMarco, T., and T. Lister. 2003. Waltzing with Bears: Managing Risk on Software Projects. Dorset Publishing Co., Inc., New York, NY.

DePillis, E., and K. Furumo. 2006. Virtual vs. Face-to-face Teams: Deadbeats, Deserters, and Other Considerations. Proceedings of SIGMIS-CPR. Claremont, CA.

Fiol, C. M., and E. J. O'Connor. 2005. Identification in face-to-face, hybrid, and pure virtual teams: Untangling the contradictions. Organization Science, 16(1), 19-32.

Gibson, C., and S.G. Cohen (eds). 2003. Virtual teams that work: creating conditions for virtual team effectiveness. Wiley, San Franciso.

Greenberg, P.S., R.H. Greenberg and Y.L. Antonucci. 2007. Creating and sustaining trust in virtual teams. Business Horizons, 50 (4), 325–333.

Henttonen, K., and K. Blomqvist. 2005. Managing distance in a global virtual team: the evolution of trust through technology-mediated relational communication. Strategic Change, 14(2), 107-119.

Hertel, G., S. Geister, and U. Konradt. 2005. Managing virtual teams: A review of current empirical research. Human Resource Management Review, 15(1), 69-95.

Hosseini, M.R., N. Chileshe. 2013. Global virtual engineering teams (GVETs): a fertile ground for research in Australian construction projects context. International Journal of Project Management, 31, 1101-1117.

Iorio, J., J.E. Taylor, and C.S. Dossick. 2012. A bridge too far: examining the impact of facilitators on information transfer in global virtual project networks, The Engineering Project Organization Journal, 2, 188-201.

Johnson, R. A., and G. K. Bhattacharyya. 2010. Statistics: Principles and Methods, 6th edition, Wiley.

Kezsbom, D., and K. Edward. 2001. The new dynamic project management: Winning through the competitive advantage, New York, John Wiley and Sons Inc.

Lee-Kelley, L., and T. Sankey. 2008. Global virtual teams for value creation and project success: a case study. International Journal of Project Management, 26 (1), 51–62.

Lipke, W., O. Zwikael, K. Henderson, and F. Anbari. 2009. Prediction of project outcome: The application of statistical methods to earned value management and earned schedule performance indexes. International Journal of Project Management, 27, 400-407.

MacDonnell, R., T. O'Neill, T. Kline, and L. Hambley. 2009. Bringing group-level personality to the electronic realm: A comparison of face-to-face and virtual contexts. The Psychologist-Manager Journal, 12(1), 1-24.

Mancini, D. J. 2010. Building organizational trust in virtual teams. Journal of Behavioral Studies in Business, 2, 1-5.

Mitchell, A., and I. Zigurs. 2009. Trust in virtual teams: solved or still a mystery? ACM SIGMIS Database, 40(3), 61-83.

Montoya, M. M., A. P. Massey, Y. T. C. Hung, and C. B. Crisp. 2009. Can You Hear Me Now? Communication in Virtual Product Development Teams. Journal of Product Innovation Management, 26(2), 139-155.

Olsson, R., 2007. In search of opportunity management: Is the risk management process enough? International Journal of Project Management, 25, 745–752.

Pauleen, D. J., and P. Yoong. 2001. Facilitating virtual team relationships via Internet and conventional communication channels. Internet Research, 11(3), 190-202.

Pogue, D., 2012. Use It Better: The Worst Tech Predictions of All Time, Scientific American, January 18, http://www.scientificamerican.com/article/pogue-all-time-worst-tech-predictions/

Purvanova, R.K., and J.E. Bono. 2009. Transformational leadership in context: face-to-face and virtual teams. The Leadership Quarterly, 20 (3), 343–357.

Stanford, D. 2014. Coca-Cola disconnects voice mail at headquarters. Bloomberg News Online, Dec 22.

Taylor, P., and G. Gao. 2014. Generation X: America's neglected "middle child.' Pew Research Center. http://www.pewresearch.org/fact-tank/2014/06/05/generation-x-americas-neglected-middle-child/

Wallace, L., and M. Keil. 2004. Software project risks and their effects on outcomes. Communications of the ACM, 47 (4), 68–73.

Walther, J. B., and U. Bunz. 2005. The rules of virtual groups: Trust, liking, and performance in computer-mediated communication. Journal of Communication, 55, 828-846.

Zhang, X., P. A. Gloor, and F. Grippa. 2013. International Journal of Organisational Design and Engineering (IJODE), 3(2), 165-184.