The Generational Impact in Virtual Teams

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ACADEMIC ABSTRACT

The world of today allows groups of people who are geographically-distributed to communicate through information and communication technologies (ICTs). In the workplace, these geographically-distributed teams are referred to as virtual teams. Quantifying and understanding issues in virtual teams has been a focus of research for the past two decades. This thesis aims to quantify generational differences between the Millennials and the Baby Boomers in the context of virtual teams in the engineering and construction sectors. This thesis consists of two studies. The first study broadly focuses on generational differences in regards to cultural, temporal, and technological issues faced in virtual teams. The results from the first study show that Millennials may be better suited to deal with cultural and language differences as well as time-distributed team members when compared to the Baby Boomers. However, the results for the technology hypothesis were mixed and motivated further research. Therefore, the second study focused on generational differences in views on specific ICTs. This study found that Millennials favored some ICTs more than their Baby Boomer counterparts. However, these generations also had indistinguishable views for many of the ICTs examined. The second study shows that the digital divide between generations is true for certain technologies but is unobservable in others. This thesis indicates that Millennials have relative strengths when handling the difficulties of virtual teaming when compared to the Baby Boomers.

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GENERAL AUDIENCE ABSTRACT

Virtual teams are teams that have members that are not all co-located and use digital technology to communicate and perform team tasks. These teams encounter difficulties that may not be experienced in the traditional face-to-face workplace. Virtual team research to date has attempted to help address these difficulties that virtual teams encounter. The virtual team literature is quite extensive and has analyzed many different constructs over the past few decades. However, this literature has failed to examine the generational impact in virtual teams in great depth. One's generation may affect how they operate as a virtual team member. This thesis aims to help quantify the generational impact in the context of virtual teams. This thesis consists of two studies. The first study broadly examines generational views on cultural diversity, temporal distribution, and technology in virtual teams. The second study examines generational views on technology in more depth. This thesis concludes that Millennials (the youngest generation in the workplace) have relative strengths as virtual team members when compared to Baby Boomers when considering cultural diversity, temporal distribution, and technology use.

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ATTRIBUTION

This thesis is composed of two manuscripts that are intended to be submitted to a journal and conference respectively for publication. This forward contains information regarding the contribution of each of the co-authors of these manuscripts. There is an additional contribution summary in Appendix C per departmental requirements.

Study #1

Samuel Ferrara – Samuel came up with the concept behind this study, did a literature review, and performed the analysis. Samuel wrote all sections of this manuscript and incorporated comments from other authors as he saw fit.

Neda Mohammadi – Neda advised Samuel on statistical analysis as well as aided him in structuring the manuscript. Neda provided periodic comments on the manuscript.

John Taylor – Dr. Taylor advised Samuel on structuring the manuscript and provided periodic comments. Dr. Taylor acted as Samuel's academic advisor and was often in contact with Samuel throughout this process.

Amy Javernick-Will – Dr. Javernick-Will provided input on the research strategy and provided periodic comments on the research.

Study #2

Samuel Ferrara – Samuel came up with the concept behind this study, did a literature review, and performed the analysis. The literature review for this manuscript was a continuation of the

one from Study #1. Samuel wrote all sections of this manuscript and incorporated comments from other authors as he saw fit.

Neda Mohammadi – Neda aided Samuel in structuring the manuscript. Neda provided periodic comments on the manuscript.

John Taylor – Dr. Taylor advised Samuel on structuring the manuscript and provided periodic comments. Dr. Taylor acted as Samuel's academic advisor and was often in contact with Samuel throughout this process.

Amy Javernick-Will – Dr. Javernick-Will provided input on the research strategy and provided periodic comments on the research.

INTRODUCTION

The world is becoming more interconnected due to the use of information and communication technologies (ICTs). The workplace of today spans countries and time zones through technology. This allows different industries, such as engineering and construction, to have a larger pool of employees to draw upon to work on their projects. These global project teams are often referred to as virtual teams. Virtual teams have been defined as "a group of people with complementary competencies executing simultaneous, collaborative work processes through electronic media without regard to geographic location" (Chinowsky and Rojas 2003, p. 98). Virtual teams experience difficulties that are different from more traditional face-to-face (FtF) teams. These difficulties often relate to the geographic distance spanned by the team or the increased dependence on technology. A team member's age may affect their views on these virtual team issues. However, there is a lack of research examining generational views in virtual teams (Gilson et al. 2015). Understanding generational views in the context of virtual teams will aid virtual team leaders and improve their ability to design effective virtual teams, therefore improving productivity.

This thesis consists of two studies that explore generational differences between the older and younger cohorts in the context of a virtual team (specifically the Millennials and Baby Boomers in the United States). These studies use data collected by Construction Industry Institute Research Team 326 (CII RT 326) to test hypotheses. The first of these studies examines the challenges and barriers of cultural differences, temporal distribution, and technology use in the context of a virtual team. Motivated by the mixed results of the first study, the second study focuses more specifically at the technologies used in the context of a virtual team and attempts to

identify exactly which technologies contribute to the digital divide between the older and younger cohorts.

STUDY 1 – Generational Differences in Virtual Teaming: Culture, Time, and Technology

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1.1. Introduction

The workplace of today benefits from being able to draw upon expertise from geographically dispersed employees to work on specific projects through the use of virtual technology (video conferencing, e-mail, etc.). However, getting these team members to work effectively together in a non-traditional setting can be challenging. Having a team made up of members who are distributed geographically and communicating through technological mediums may lead to issues that a face-to-face (FtF) team would not encounter. Virtual teams will not succeed if they do not learn to "adjust to this new reality" (Lipnack and Stamps 2000, p. 19), a reality which may include cultural and linguistic diversity (Staples and Zhao 2006). In addition, if the team is spread across different time zones, team members may also have to cope with temporal (time) boundaries. Therefore, geographic distribution can lead to cultural, linguistic, and temporal diversity. Difficulty with the technology that is being used to break down these cultural and language barriers as well as temporal boundaries can intensify the problem by negatively affecting team performance.

Individual team members tend to react and adjust to these virtual teaming challenges differently. Generational differences could contribute to differing points of view regarding the impact of cultural differences, temporal boundaries, and technology. The Pew Research Center (2015a) has identified four prominent generations that are of working age – Millennials, Generation X, Baby Boomers, and the Silent Generation. This is likely the first time there have been four distinct generations in the workplace simultaneously (Bennett et al. 2012; Downing 2006). Having more generations in the workplace increases the number of cross-generational interactions and magnifies the potential impact that generational differences could have on a virtual team. As previously mentioned, cultural diversity, time distribution, and technology are important aspects

of virtual teaming, for which generations have been described as having differing views. These differences could be detrimental to a virtual team if not fully understood. Conversely, generational strengths are more likely to be leveraged if they are better quantified. Therefore, it is important to understand differing generational views on culture, temporal boundaries, and technology in the context of the virtual team environment.

1.2. Literature Review

It is essential to understand what constitutes a virtual team before moving on to consider potential generational impacts. Although there is no common definition of virtual teams in the literature, several themes emerge when reviewing virtual team definitions. Many definitions imply that virtual teams are being challenged to overcome boundaries and barriers such as cultural differences or temporal distribution through the use of a technological medium. The following subsections include a review of the relevant literature focused on these concepts.

1.2.1. Culture

The ability for virtual teams to cross geographic boundaries through technology generally results in more culturally-diverse teams. Chinowsky and Rojas (2003) describe that a virtual team functions "without regard to geographic location" (p. 98). Similarly, Hosseini and Chileshe (2013) offer a definition that indicates that Global Virtual Engineering Teams (GVETs) are often distributed spatially. This geographic distribution will make teams cross international borders, causing global virtual team (GVT) members to come from different national backgrounds (Jarvenpaa et al. 1998). Varying national backgrounds will lead to cultural differences in these teams. Chen and Messner (2010) make the connection between spatial distribution and cultural

differences when they describe GVETs as teams that are “geographically dispersed” and cross “cultural barriers” (2010, p. 208).

It has been argued that cultural diversity is linked to global virtual team conflict (Kankanhalli et al. 2006). Staples and Zhao (2006) found partial support that cultural diversity can lead to conflict and less contentment within virtual teams. Project teams that experience cultural and language diversity have been found to exhibit poorer performance during early project phases when compared to more culturally and linguistically homogenous teams (Comu et al. 2011). Technology can help to mitigate these types of issues typically encountered in cross-cultural communication. For instance, Shachaf (2008) has proposed that e-mail can improve cross-cultural communication in virtual teams as it allows participants that do not speak the primary language of the team as their first language to communicate their thoughts more effectively. E-mail also allows team members more time to consider information and formulate a response in comparison to more synchronous technologies. Culturally heterogeneous groups tend to use technology differently than their homogenous counterparts. For example, it has been found that global virtual teams will turn to technologically mediated boundary objects sooner than domestic virtual teams “during conflict identification” (Iorio and Taylor 2014, p. 14). It is also important to note that not all virtual teams are completely culturally heterogeneous. Daim et al. (2012) have found a complaint of virtual team members is that the cultural distribution in the teams can be skewed. During interviews, they found that participants in GVTs that meet in “real-time” largely consist of team members from English-speaking cultures (Daim et al. 2012, p. 202).

1.2.2. Time

The same spatial distribution that can lead to cultural differences can also lead to a time-dispersed team (having team members in different time zones). Chen and Messner (2010) stress in their definition that time distribution is an issue that virtual teams must "overcome" (p. 208). In their definition, Lipnack and Stamps (1999) also highlight the need for these teams to be able to span time zones effectively. In agreement with other definitions, Hosseini and Chileshe (2013) suggest in their definition that virtual teams may experience temporal boundaries. Time zones add to the complexity experienced in virtual team collaboration.

Having team members located in different time zones may cause meetings to be held outside of typical work hours. This could explain why virtual team members who meet simultaneously have been reported to have a "poor work-life balance" (Daim et al. 2012, p. 202). Time zones can be more difficult for virtual teams to deal with than the physical distance spanned by the team members (Cummings et al. 2009). Temporal distances have been found to contribute to coordination delays in virtual teams (Cummings et al. 2009). Research has also identified a 9-12 hour time difference amongst team members as having the most intense negative effect on coordination (Espinosa et al. 2012).

1.2.3. Technology

Virtual team definitions, for the most part, agree that time and cultural differences are common barriers faced in the virtual environment. But how do virtual teams break down these barriers? Many definitions state that virtual teams communicate through a technological medium (Chen and Messner 2010; Chinowsky and Rojas 2003; Hosseini and Chileshe 2013; Lipnack and Stamps 1999). Accordingly, both time differences (Lipnack and Stamps 1999) and cultural

differences (Chen and Messner 2010) can be spanned by taking advantage of appropriate technological affordances.

Information and communication technologies (ICTs) appear to be the most common type of technology examined in the context of virtual teams. ICTs include technologies such as e-mail and video conferencing. Video conferencing attempts to mimic FtF meetings. However, it has not been shown to be as productive as FtF meetings (Andres 2002). "[S]ynchronous" and "asynchronous communication" through technology have been found to be effective in limiting coordination issues when team members have work hours that intersect (Cummings et al. 2009, p. 434). ICTs enable virtual teams to communicate and help span the barriers experienced in the virtual environment.

Virtual teams face barriers and challenges related to cultural diversity, time distribution, and reliance on technology for communication. Generational differences may exacerbate these difficulties experienced in the virtual environment. However, this has not been well-quantified in the context of a virtual team. Therefore, research is needed that focuses specifically on quantitatively examining generational views on culture, time, and technology.

1.2.4. The Generational Point of View

A generation has been defined as a set of individuals of similar ages that experiences "significant life events at critical developmental stages (times)" (Kupperschmidt 2000, p. 66). These generations can be split into different groups depending on when in the generational time-frame they are born (early, middle, late) (Kupperschmidt 2000). As previously mentioned, there are four generations in the workplace today (Bennett et al. 2012; Downing 2006). The newest of these generations is the Millennial generation. The Millennials (born 1981-2001) are followed in

age by Generation X (1965-1980) and then by the Baby Boomer generation (1946-1964). The oldest generation in the workplace today is the Silent Generation (1928-1945) (Pew Research Center 2015a). These generations have been characterized in the literature when views on cultural diversity, temporal issues in the workplace, and technology are separately considered. Research has examined how the most recent cohort to enter the workforce differs from previous generations, and this study adopts a similar approach.

This study aims to look specifically at the differences between the Millennials and the Baby Boomers. These generations do not exhibit the overlap that would be experienced if two consecutive generations were examined, thus ensuring two distinct groups. In 2015, the Millennials represented 34% of the workforce, while the Baby Boomers represented 29% (Pew Research Center 2015b). In contrast, in 1995 the Millennials were not present in the workforce while the Baby Boomers comprised nearly half of it (Pew Research Center 2015b). Many Baby Boomers are now in "leadership positions" (Gibson et al. 2011, p. 2) while younger employees will likely tend to hold entry level positions. Examining these two specific generations will shed light on key differences experienced between the younger and older cohorts in the workforce.

The Millennials have been characterized as having differing views on cultural differences (Myers and Sadaghiani 2010). Culture is a broad term that encompasses aspects of race, ethnicity, and language as well as other constructs. Millennials have been characterized as not tolerating a lack of "racial diversity" (Martin 2006, p. 8). In agreement with other characterizations, Bell and Narz (2007) and Downing (2006) describe the youngest generation as being at ease when experiencing diversity, although neither employed robust statistical analyses to make these claims. Downing (2006) also states that the Millennials are "the most culturally diverse generation yet" (p. 6). The Millennials have also been characterized as the most diverse generation yet in terms of race and

ethnic backgrounds (Nielsen Company 2014). Still, research published to date has yet to establish why Millennials are more accepting in their views on diversity and cultural differences. Research has also failed to completely address the older generations' (such as the Baby Boomers) views on cultural diversity. This study seeks to clarify if the Millennials have a relative strength of better handling cultural diversity when compared to the Baby Boomers.

Generational views on time distribution in the workplace is a topic that has not been examined in great depth in the current literature. However, generational views on the relation between work and time have been discussed occasionally in the literature. For example, Millennials have been said to seek a "work-life balance" (Baldonado 2013, p. 42; Downing 2006, p. 6) and more "flexible work arrangements" (Bell and Narz 2007, p. 57). However, the younger cohort may find conflict with older cohorts related to scheduling differences as observed by Kankanhalli et al. (2006). Their less rigid views on temporal boundaries in the workplace could make Millennials more reliable contributors in distributed virtual teams that may require participation outside of normal working hours. The Millennials also desire to have jobs that allow telecommuting (Bell and Narz 2007), showing a more fluid conception of the boundaries of work and time than previous cohorts. In contrast, the Baby Boomers have been characterized as being in opposition with these more flexible work arrangements (such as telecommuting) (Glass 2007). In addition, Brody et al. (2011) note that the older generations (such as the Baby Boomers) were raised in a society where "9-to-5" workdays were the norm and found that changing these temporal norms will negatively affect the "loyalty" of the older cohorts (p. 170). However, Brody et al. (2011) do not exclusively examine the Millennials and the Baby Boomers. Despite all these characterizations in the literature, there is still a severe lack of quantitative research of

generational views on time-distributed work environments. This gap is especially present for the older cohorts such as the Baby Boomers.

The Millennials have been said to have a "competitive advantage" due to their affinity for technology (Kaifi et al. 2012, p. 89). The younger cohort has even been proposed to be well-suited to be co-leaders (alongside older generations) of virtual teams due to their technological competence (Iorio and Taylor 2015). Millennials have also been referred to as "'digital natives'" (Hershatter and Epstein 2010, p. 212) as they have been learning to use technology throughout their lives (Simoneaux and Stroud 2010). In comparison, the older generational cohorts, such as the Baby Boomers, learned "modern technology" either in an educational setting or on the job (Simoneaux and Stroud 2010, p. 70). Wang and Haggerty (2011) have proposed that using ICTs for personal matters may increase virtual competence. The Millennials generally have more exposure to ICTs in their personal lives compared to the Baby Boomers as the 'digital native' contention argues. However, it is important to note that previous generations were also affected by new technology such as the advent of the television (Deal et al. 2010). Nonetheless, the Millennials likely have a better modern technological literacy when compared to the Baby Boomers due to their increased exposure at a young age.

Despite the large amount of research regarding characteristics of generations, there is a dearth of knowledge regarding the generational impact in virtual teams (Gilson et al. 2015; Myers and Sadaghiani 2010). Given the differences found across generations in the workplace, this study aims to examine how and whether such differences manifest in the context of virtual teams in the areas of cultural differences, temporal boundaries, and technology use.

1.3. Hypotheses

Generational differences have been identified by researchers in regard to cultural issues, temporal boundaries, and technology use. The following hypotheses have been developed based on a careful consideration of both the existing virtual team research and generational research. Culture and language differences (H1) (e.g., Chen and Messner 2010), time (H2) (e.g., Lipnack and Stamps 1999), and technology (H3) (e.g., Chinowsky and Rojas 2003) are essential elements of virtual teaming. Language diversity is assumed to be related to cultural diversity and is therefore included in H1. The Millennials are the generation that has most recently entered the workforce. In comparison, the Baby Boomers hold power in the workplace and have represented the largest demographic for much of the time preceding the Millennials entrance to the workplace. In addition, these two generations do not have the overlap that would be experienced if two consecutive generations were analyzed. Therefore, this study examines the differences between the Millennials and the Baby Boomers.

Millennials have been characterized in the reviewed literature as being especially skilled at dealing with cultural diversity (e.g., Bell and Narz 2007; Downing 2006) as well as being the most diverse generation yet (Nielsen Company 2014). This leads us to our formulation of H1:

> **H1** – *Millennials view cultural and language differences as less of a barrier and challenge compared to Baby Boomers in the context of a virtual team.*

Millennials have also been characterized in the reviewed literature as having a more fluid sense of time in the context of the workplace (e.g., Baldonado 2013; Downing 2006). This leads us to our formulation of H2:

H2 – *Millennials view time distribution amongst team members as less of a barrier and challenge compared to Baby Boomers in the context of a virtual team.*

Finally, Millennials have been characterized as being proficient with technology in the reviewed literature (e.g., Simoneaux and Stroud 2010). This leads us to our formulation of H3:

H3 – *Millennials view technology use and implementation as less of barriers and challenges compared to Baby Boomers in the context of a virtual team.*

1.4. Methodology

The research presented in this paper is based on the efforts of Construction Industry Institute Research Team 326 (CII RT 326) which focused on maximizing the performance of virtual teams in the engineering and construction industry. CII RT 326 developed a survey instrument and collected survey data. The survey was distributed to approximately 1,386 individuals. A total of 207 survey responses were collected from participants with experience working in virtual teams. The survey population included participants from the Silent Generation, Baby Boomers, Generation X, and Millennials (distribution of participants by generation provided in Table 1). The participants worked in a number of different engineering and construction sectors and varied by age. It is important to note that generations are unique to certain areas of the globe. Millennials and Baby Boomers are well agreed-upon generations in the United States, but other areas of the world may not recognize similar generations. Therefore, responses from individuals working outside the United States were not analyzed. This left 84 Baby Boomer responses and 40 Millennial responses that were analyzed for this study (n=124). Table 2 shows information on the companies that employ the Millennials and Baby Boomers considered in the analysis (n=124) as well as the participants' positions.

Table 1 – Generation Distribution (n = 207)

Generation	Participants
Silent Generation (before 1946)	3
Baby Boomers (1946-1964)	88
Gen X (1965-1980)	75
Millennials (1980-2001)	41

Note: The survey read "before 1946." However, the Silent Generation has been defined as having birth years ranging from 1928-1945 (Pew Research Center 2015a)

Table 2 – Company Information for Domestic Millennials and Baby Boomers (n = 124)

Company Type	*Engineer/Contractor*	52%
	Private Owner	23%
	Public Owner	24%
Company Reach	*Local (in-state)*	1%
	Regional	3%
	National	6%
	Multinational	90%
Number of Employees	*<100*	2%
	100-500	3%
	501-1,000	12%
	1,001-5,000	17%
	50,001-10,000	15%
	10,001-50,000	16%
	>50,000	34%
Participants' Positions	*Project Engineer*	23%
	Project Management	29%
	Upper Management	15%
	None of the Above	32%

Seven (7) questions from the survey were selected to test the hypotheses (Table 3). These questions are listed on the following page. The selected questions all used a 5-point Likert scale for responses. The Likert scale responses showed the participants' level of agreement with statements (ranging from Strongly Agree / Very Challenging to Strongly Disagree / Not Challenging).

Table 3 – Questions Linked to Each Hypothesis

Hypothesis	Questions Analyzed
H1	1, 2, 3
H2	4, 5
H3	6, 7

i) Question 1 – How challenging is dealing with different languages in virtual team collaborations (in your organization)? (1= Not Challenging, 5 = Very Challenging)

ii) Question 2 – How challenging is dealing with different cultures in virtual team collaborations (in your organization)? (1= Not Challenging, 5 = Very Challenging)

iii) Question 3 – In your experience, to what extent do you agree that the following items are barrier(s) to effective virtual teams? – Cultural/language differences (1 = Strongly Disagree, 5 = Strongly Agree)

iv) Question 4 - How challenging is dealing with different time zones in virtual team collaborations (in your organization)? (1= Not Challenging, 5 = Very Challenging)

v) Question 5 – In your experience, to what extent do you agree that the following items are barrier(s) to effective virtual teams? – Time difference between distributed team members (1 = Strongly Disagree, 5 = Strongly Agree)

vi) Question 6 - How challenging is the use of virtual technologies in virtual team collaborations (in your organization)? – (1= Not Challenging, 5 = Very Challenging)

vii) Question 7 – In your experience, to what extent do you agree that the following items are barrier(s) to effective virtual teams? – Difficulty with technology implementation (1 = Strongly Disagree, 5 = Strongly Agree)

The selected Likert scale questions were analyzed using pooled one-tailed t-tests to compare the differences between the Millennials' and Baby Boomers' responses ($H_a = \mu_{Millennials} < \mu_{Baby\ Boomers}$). Variances were assumed to be equal based on the results of a 2-sided F-test for unequal variances. Qualitative responses were converted to numerical values (Strongly Agree = 5, Agree = 4, etc.). A p-value of ≤ 0.05 was used to determine significance. Parametric tests are a valid statistical approach to analyze Likert scale responses as Norman (2010) attests. Norman (2010) cites the Central Limit Theorem to explain that if the number of responses is "greater than 5 or 10 per group" then the distribution of the means can be assumed to be "approximately normal" (p. 628). Therefore, the distribution of the means can be assumed to be normal considering the sample size (Millennials (n=40) and Baby Boomers (n=84)).

1.5. Results

The t-test scores and means for the selected survey questions are displayed in Table 4. All three questions (1, 2, & 3) corresponding to H1 show that the Millennials' responses were statistically significantly lower than the Baby Boomers' responses. Therefore, support was found for H1 showing that Millennials view cultural and linguistic diversity as less of a challenge and a barrier in the context of a virtual team when compared to their Baby Boomer counterparts. The two questions corresponding to H2 (4 & 5) show again that the Millennials' responses were statistically significantly lower than the Baby Boomers' responses. Therefore, support was also found for H2 showing that Millennials view time-distributed team members as less of a challenge and a barrier when compared to the views of their Baby Boomer counterparts. Statistically significant support was found for Question 6, but was not found for Question 7. Therefore, H3 (technology) cannot be fully supported.

Cronbach's alpha was calculated for the three hypotheses – H1 (α = 0.8341), H2 (α=0.6997), and H3 (α=0.5041). The Cronbach's alpha results for H3 show that Questions 6 and 7 may actually be testing different constructs (as revealed by the substantially differing p-values for these questions). Questions 6 and 7 will be discussed separately in the next section.

Table 4 – Summary of Hypothesis Test Results

Hypothesis		Survey Question	Likert Scale Means		p-value
			Millennials (n = 40)	Baby Boomers (n = 84)	
H1	Millennials < Baby Boomers	1	2.200	2.952	0.0015**
		2	2.150	2.786	0.0033**
		3	2.600	3.119	0.0065**
H2	Millennials < Baby Boomers	4	2.525	2.929	0.0242*
		5	2.700	3.310	0.0011**
H3	Millennials < Baby Boomers	6	2.150	2.583	0.0254*
		7	3.625	3.619	0.5116

* $p<0.05$
** $p<0.01$

1.6. Discussion

The results for H1 show that the characterization in the literature of the younger generation having more encompassing views on the topic of cultural diversity appears to be true in the context of virtual teams (e.g. (Myers and Sadaghiani 2010)). As Bell and Narz (2007) argue, this youngest generation may be more comfortable with cultural diversity since they were exposed to it more in their schooling. As the generational definition provided by Kupperschmidt (2000) hints, a generation is formed by common experiences during their youth. This exposure to diversity in the Millennials' schooling is thus likely to have helped define this youngest generation. Millennials are also characterized by their relatively higher levels of diversity in their demographical makeup (Nielsen Company 2014). Possibly, the Millennials are constantly exposed to more diversity due to exposure to their generational peers and have thus developed strengths related to handling cultural diversity.

As Kankanhalli et al. (2006) proposed, cultural diversity can lead to conflict in a virtual team. It is not clear, however, if the Millennials are actually less prone to conflict when compared to their older generational counterparts. Studying generational proneness to conflict in virtual teams is an opportunity for future research. Millennials may be able to help reduce conflict by aiding in cross-cultural communication in virtual teams. Cultural boundary spanners (CBSs) are already a topic discussed in the virtual team literature (e.g., Ramalingam and Mahalingam 2011), but this topic warrants further study in the context of generational differences.

The results for H2 support the characterization in the literature of Millennials having a more fluid conception of time and work than previous cohorts. As discussed earlier, Millennials seek out opportunities for telecommuting (Bell and Narz 2007). Telecommuting may increase worker

availability outside of normal work hours. It is unclear if these differences are attributed to generational differences or age differences. It is possible that all young people (regardless of generation) prefer to work on a less-rigid work schedule. This is another topic that warrants future research.

In the generational literature, the "work-life balance" described by Downing (2006, p. 6) and Baldonado (2013, p. 42) is unclear. Work-life balance may relate to either the overall hours worked weekly (i.e., 40 hours/week) or the distribution of those hours (i.e., five 8-hour days, four 10-hour days). Globally-distributed teams will require team members to be flexible with their distribution of their hours (i.e., staying late to meet with team members in different time zones). Bell and Narz (2007) have suggested that Millennials want to work in a flexible environment. This desired flexibility could make the Millennials more willing to accept the challenge of working the odd hours that time-distributed teams may encounter, as our results show. The results for H2 help demonstrate that the "work-life balance" desired by the Millennials may not actually be related to the distribution of the hours worked, since they appear to be more willing than the older cohort to work odd hours to accommodate their time-distributed team members.

The Millennials have also been characterized as having a "'work-to-live' mentality" (Ferri-Reed 2014, p. 20). This could mean that Millennials would view time distribution as more of a challenge and barrier than older generational cohorts. In contrast, Baby Boomers are described as "workaholic[s]" (Simoneaux and Stroud 2010, p. 69). This characterization of the Baby Boomers implies that they would be more willing to work the extended hours that can be required of a time-distributed team. The Millennials look for "ample feedback" (Hershatter and Epstein 2010, p. 218) and are considered to be "collaborative" (Ferri-Reed 2014, p. 21). The desire for feedback and collaboration may make the Millennials more willing to work extended hours to

meet with their time-distributed virtual team members. Existing generational characterizations do not explicitly call out their views on working in a time-distributed team (these views can only be inferred). The results from our study clarify generational views on working as a member of a time-distributed team. Our results demonstrate that Millennials (when compared to the Baby Boomers) view time-distributed team members as less of a barrier and a challenge in the context of a virtual team. Still, there appears to be no consensus in the literature on how Millennials (or any generation, for that matter) are impacted by working with time-distributed team members and this represents an avenue for future research.

The results for H3 support the assumption that Millennials struggle less with technology use than the Baby Boomers (Question 6). However, the two cohorts are nearly indistinguishable when views on technology implementation are considered (Question 7). Note, however, "technology use" is different than "technology implementation." Technology use refers to the practice of interacting with an existing technology. In comparison, technology implementation refers to the practice of introducing and learning a new technology.

The results for Question 7 (technology implementation) are similar to points offered from Deal et al. (2010). They acknowledge that this youngest generation may "use technology differently" when compared to their older cohorts (p. 192). However, they also acknowledge that this relationship is not unique to today's generations (2010). They go on to say that it is not yet known if the Millennials "will be more fundamentally affected by the explosion of technology options when compared with previous generations" (p. 193). With that thought in mind, it is logical to propose that the rate of technology implementation in recent decades makes it hard for the Millennials (or any other generation) to cope with this implementation. It may be that the Baby Boomers are equally equipped to implement technology in the context of a virtual team

when compared to their Millennial counterparts, as our results show. Technology implementation is also related to an organization's ability to implement new technology, while technology use relates more to personal ability to use technology. Possibly, each of these generations equally quantifies the barrier of technology implementation within their organizations.

In contrast, the results for Question 7 may be in conflict with Simoneaux and Stroud (2010) who state that the Millennials are "always looking for the next cool thing" when it comes to technology (p. 69), which suggests that Millennials may view the task of implementing a new technology as less of a barrier. Further defining generational differences and views in regards to implementing new technology (particularly ICTs) is a topic for future research.

Virtual teams use a great deal of "work technology" (e-mail, video conferencing, etc.). This is different from "social technology" (texting, social media, etc.). The Millennials may have a higher technological literacy when social technology is concerned as they were likely exposed to social technologies (such as Facebook) during their formative years. As Downing (2006) notes, the Millennials will often defer to their "social network" for guidance (p. 5). This competence with "social technologies" during a young age may well translate to competence with "work technology." It has been proposed that proficiency with ICTs outside of the work setting will transfer to more virtual competence in the work setting (Wang and Haggerty 2011). The results from our study support Wang and Haggerty's (2011) proposition. Millennials view technology use as less of an issue than Baby Boomers in the context of a virtual team. This may be from competence with "social technology" gained at a young age.

1.7. Limitations and Future Research

The absolute differences between the generational means for the survey questions were statistically distinct in most cases. However, it is not clear if these differences are practically significant or if these differences would be noticeable in the context of a virtual team. Possibly, the 5-point Likert scale limited the absolute difference in the means. If a finer-grained scale was used, these absolute differences may have been more substantial. Also, this study only looked at the views of virtual team members working in the United States. However, many virtual teams have members working globally. This limits confidence when applying the findings of this study to global virtual teams. Future research should test if the findings of this study hold true for a more globally-diverse set of survey participants. In addition, this study had 32% of participants that categorized their position as "none of the above." This limits confidence in the findings since it is impossible to know what proportions of the participants are in managerial roles versus administrative roles.

This study has done a broad overview of generational views on three major constructs in virtual teaming. Generational views on each of these constructs warrants future research. In the case of the culture and time hypotheses, future research can serve to confirm and refine the findings of this study. However, future research in regards to generational views on technology in virtual teams should focus on distinguishing generational views on technology use and technology implementation as well as examining specific ICTs commonly used in virtual teams.

1.8. Conclusions and Implications

The results from this study support some of the generational characterizations that have been reported in the literature. This study extends this literature by examining these characterizations

in the context of a virtual team. The Millennials exhibited statistically distinct and lower means (less challenging / less of a barrier) than the Baby Boomers in their responses to all but one of the questions analyzed suggesting this generation has relative strengths when compared to their Baby Boomer counterparts. These strengths are particularly noticeable when views on cultural and language differences, as well as time-distributed team members, are considered. Millennials have been thought to have a "competitive advantage" when using technology (Kaifi et al. 2012, p. 92). However, the Millennials may also be at an advantage in the modern workplace in terms of cultural and time distribution issues. Conversely, the findings show that the Millennials are not different from the Baby Boomers with respect to issues related to technology implementation. The youngest generation may be suited for co-leadership roles alongside their older counterparts in virtual environments as proposed by Iorio and Taylor (2015). This assertion was based on this cohort being suited to be virtual leaders due to their technological competence. The findings from this study add to this assertion. According to the results in this study, Millennials are also suited to be virtual team leaders due to their relative ease in dealing with cultural, language, and temporal differences.

This study provides quantitative evidence for the existence of generational differences in virtual teams. This fills a gap in both the generational and virtual team literatures. The findings from this study have important implications for virtual team project leaders. The results show that Millennials likely have strengths related to overcoming the challenges and barriers of cultural diversity and temporal distribution in a virtual team. This study also shows that Millennials view technology use as less of a challenge than their Baby Boomer counterparts. Virtual team leaders will benefit from these findings and can use them to better deploy Millennials to tasks where their strengths can be best leveraged.

STUDY 2 – Exploring Generational Preferences Toward Information and Communication Technologies in Virtual Teams

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2.1. Introduction

The world is becoming more interconnected. This is partially due to the increased availability of the internet and the ease of access to multiple types of information and communication channels it makes possible. In the United States, the number of households with access to the internet rose from 58.1% in 2005 to 79.6% by 2014 (World Bank 2016). A similar growth in access to digital technology has also taken place in the workplace, where globalization is no longer a prediction for the distant future but a reality that many workers are already experiencing. Globally-distributed workers are often members of virtual teams. A virtual team has been defined as "a group of people with complementary competencies executing simultaneous, collaborative work processes through electronic media without regard to geographic location" (Chinowsky and Rojas 2003, p. 98). Communication that used to be limited to face-to-face (FtF) interactions can now be done using information and communication technologies (ICTs) in virtual teams. ICTs have been suggested to be the "core mechanisms for interactions" in virtual teams (Thomas and Bostrom 2010, p.116). A lower preference for using ICTs among team members may, therefore, reduce the performance of virtual teams in some instances, and a team member's age could play a role in their perceptions of ICTs. In today's workplace, there are often four generations working simultaneously (Bennett et al. 2012; Downing 2006). The youngest of these generations (often referred to as Millennials) may have differing views on the ICTs that are used compared to others in a mixed-generation virtual team. It has been argued that the Millennials are "digital natives" who are more comfortable using advanced technologies as they have grown up using them (Hershatter and Epstein 2010, p. 212). This characterization of the youngest cohort as being more technologically competent suggests that there could be a major generational divide among virtual team members with regards to their technological preferences that could affect team

performance. However, studies often fail to examine generational views on multiple ICTs, and, therefore, fail to examine the full extent of the digital divide between older and younger cohorts in the workplace. Thus, the aim of this study is to identify generational views on specific ICTs that are used in virtual team communication. The objective is to identify the specific ICTs that exacerbate this generational digital divide.

2.2. Background

Information and communication technologies (ICTs) can "consist of hardware, software, networks, and media for collection, storage, processing, transmission, and presentation of information (voice, data, text, images)" (World Bank Group 2002, p. 3). ICTs range from e-mail to video conferencing and may be either asynchronous (e-mail) or synchronous (video conferencing) in nature. ICTs help bridge the cultural, geographic, and temporal barriers that are often experienced in virtual teams. It has been claimed that a virtual team's demographic makeup can serve as a prompt for the team to change certain ICTs that they use (Thomas and Bostrom 2010), even though in an existing virtual team this may lead to confusion among members and could possibly lower performance. Therefore, it is important that we understand how team demographics as described by Thomas and Bostrom (2010) will influence ICT use in virtual teams. We propose that demographic information, specifically age or generation, will have a major impact on ICT preferences in virtual teams. This section will examine different types of ICTs reviewed in the literature and how generations (specifically the Millennials and the Baby Boomers) view them.

2.2.1. ICT Types, Features, and Aspects

The ICT types, features, and aspects that virtual teams use cover a vast range; the sheer number of ICTs that have been developed for use in virtual teams makes it a daunting task to categorize them into a concise list of groupings. Nevertheless, researchers such as Malhotra and Majchrzak (2012) and Mittleman et al. (2008) have categorized ICTs in their studies. Malhotra and Majchrzak (2012) categorized ICTs depending on whether they were exchanging "boundary objects or tacit knowledge" (p. 6:10). Mittleman et al. (2008) divided their "collaboration technologies" into four categories – Jointly authored pages, Streaming technologies, Information access Tools, and Aggregated systems (p. 311).

For this research, which was carried out under the Construction Industry Institute Research Team 326 (CII RT 326), we developed and distributed a survey that considered ICTs that have been specifically developed to serve the needs of virtual teams that work in engineering and construction. We have since categorized the specific ICTs from this survey into four categories – (1) Meeting/collaborating, (2) Tracking/documenting, (3) Information sharing, and (4) Other. These specific technologies are listed in Table 5.

When categorizing the ICTs in the CII RT 326 survey we found that many ICTs fit into multiple categories. For example, email is often used for "formal" correspondence (Vartiainen and Jahkola 2013, p. 395). However, email is also used for sending documents/files in virtual teams (Vartiainen and Jahkola 2013). Therefore, email has features that relate to both the *Meeting/collaborating* and *Information sharing* categories. Another ICT that fits into multiple categories is instant messaging. Instant messaging, which as well as being used in virtual teams for "informal communication," can also let users know if their fellow teammates are online at

that moment (Vartiainen and Jahkola 2013, p. 395), thus exhibiting features that fit into both the *Meeting/collaborating* and *Tracking/documenting* categories. Other researchers have also noted that some ICTs may fit into multiple categories such as Mittleman et al.'s (2008) Aggregated systems category which includes tools that incorporate multiple technologies (p. 312). For this study we have categorized ICTs in terms of their primary intended functions rather than their sub-functions or sub-features, as shown in Table 5, thus enabling us to assign a single category for each ICT.

Table 5 – ICT Abilities identified in the CII RT 326 Survey

Meeting/Collaboration	*Collaborate through web-based project workspace software*
	Use the same collaboration technology across projects (e.g., all team members have equal access to technology)
	Use a project email system (e.g. Aconex)
	Send instant messages to virtual teammates
	See virtual teammates
	Notify virtual teammates when you wish to speak (e.g., virtually raise your hand)
	Simultaneously collaborate virtually on documents
	Virtually collaborate using mobile devices
	Tag key components during presentations (e.g., to come back with questions)
	Tell a virtual collaborator they have done a good job (e.g., virtual thumbs up)
	Access multiple communication modes
	Hold impromptu conversations/meetings
Tracking/ Documenting	*Record/track/publish conversations*
	Provide transcripts from conversations
	Know which of your virtual teammates are currently online
	Know how long your virtual teammates have been off-line
	Check virtual teammate meeting availability
	Monitor and communicate project progress
Information Sharing	*Share screens with annotation capability (e.g., for document/model reviews)*
	Share screens
	Share files
	Share folders (e.g., Google Drive or ProjectWise or Dropbox)
Other	*Remotely control another teammate's shared screen*
	Simultaneously point to different elements when screen sharing
	Make social media connections/postings
	Reliably connect (e.g., bandwidth)
	Use encryption when transferring files over the Internet

2.2.2. Category Definitions

- *Meeting/collaborating ICTs*: This category contains much of the technologies and features that allow real-time collaboration among team members, which broadly relates to Malhotra and Majchrzak's (2012) categorization of ICTs that share "tacit knowledge" (p. 6:10). Simultaneous collaboration allows team members to communicate information that cannot be quantitatively or explicitly recorded. ICTs in this category include project email systems and those designed to facilitate instant messaging and virtual collaboration on mobile devices.
- *Tracking/documenting ICTs*: This category contains technologies and features that allow virtual team members to record information or observe teammate activity. This category includes ICTs that would be used to help team members decide if they want to initiate communication with other team members by checking their availability (tracking team members). This category also includes documentation of previous conversations.
- *Information sharing ICTs*: This category contains any technology or feature that allows virtual team members to share boundary objects through screen or file sharing. This is similar to both Malhotra and Majchrzak's (2012) "boundary objects" (p. 6:10) and Mittleman et al.'s (2008) Information access tools categories. Both our category and these relate to sharing files. However, we also include sharing screens in this category unlike Mittleman et al. (2008). File sharing can be done through multiple methods such as FTP servers or through email. Vartiainen and Jahkola (2013) note that FTP servers can be used for files that exceed the size limitations of files being sent through email.

- *Other ICTs*: There were 5 ICTs that did not fit into any of the above categories. Therefore, we have developed a miscellaneous (or 'Other') category to enable us to address these ICTs. A notable ICT in this category relates to social media. Social media is particularly important in the context of the present study as it is often a major topic in generational studies on technology use. It has been found to be a highly favored mode of communication among students of various ages and cultural backgrounds (Omari 2012).

2.2.3. The Millennial Point of View

The Millennials (born 1980-2001) are the youngest generation in the workforce today. They are often characterized as being more proficient with modern technology and have been shown to value ICTs such as instant messaging and email (Glass 2007). They are sometimes referred to as "digital natives" (e.g., Hershatter and Epstein 2010, p. 212) because they have been exposed to technology for their whole lives (Simoneaux and Stroud 2010). It has been reported that being exposed to ICTs contributes to more successful "ICT innovation" while managing construction sites (Usman and Said 2012, p. 1266). Relating to innovation, this youngest cohort has also been described as being "early adopters of new technology" (Kumar and Lim 2008, p. 570). Millennials are characterized as a cohort that is particularly well-suited to work in a dynamic environment that depends on ICTs for team collaboration.

2.2.4. The Baby Boomer Point of View

The other generational cohort examined in this study includes many of the older workers currently active in the workforce, the Baby Boomers (born between 1946 and 1964), many of whom have now risen to hold "leadership positions" (Gibson et al. 2011, p. 2). Simoneaux and Stroud (2010) have noted that the technological environment in the "high-tech workplace" of

today is very different to the environment experienced by Baby Boomers outside the workplace (p. 70). Baby Boomers grew up in a time before many of the common ICTs of today were a part of the workplace, and it has been argued that as a result Baby Boomers place a greater importance on "face-to-face communication" (Glass 2007, p. 100). However, Baby Boomers are generally characterized as being more accepting of technology compared to the generation that preceded them (Kumar and Lim 2008). Still, there appears to be a lack of evidence (if any) that demonstrates that Baby Boomers are more skilled with technology compared to the younger cohorts in the workplace today. When considering the reviewed literature, the Baby Boomers are, at best, equal to Millennials in regards to technological ability, though they likely lag behind this youngest cohort.

2.2.5. The Digital Native Debate

Much of the academic and popular literature characterizes the Millennials as 'digital natives' because they have been exposed to digital technologies throughout their lives and, therefore, characterizes them as being more proficient with ICTs in comparison to older cohorts. Still, the notion of digital natives being more proficient with technology is not fully agreed upon in the literature. Some researchers have observed that this perceived gap with regard to technology use and preferences between the younger and older cohorts may not be either severe or even noticeable. Waycott et al. (2010) found no support for the notion of a technological divide between students and teachers in an Australian university due to participants' differing experience with technology. Bennett et al. (2008) reached similar conclusions on this debate and contended that the younger cohort should not be considered as being different from other cohorts. Likewise, Rothe et al. (2012) found only small differences when views were compared between age cohorts on "virtual and mobility preferences" in the workplace (p. 86).

The literature we reviewed for this study found that there is no consensus on generational viewpoints with regard to digital technologies (such as ICTs) in the workplace. In addition, much of the reviewed literature failed to analyze generational views on multiple technologies. Our study aims to determine exactly which ICTs (if any) exhibit significant generational differences in use and preference. This will allow us to identify the specific ICTs that are contributing to the generational divide that has been so widely discussed in the reviewed literature.

2.3. Hypothesis

We examined two generational cohorts in our study – Millennials and Baby Boomers. The Millennials are relatively new to the workplace, while the Baby Boomers have now progressed to the point in their careers where they hold "leadership positions" (Gibson et al. 2011, p. 2). These two generations, therefore, provide a good point of comparison. Analyzing these two generations also limits potential crossover effects that would be observed if two consecutive generations are analyzed (i.e., Millennials and Generation X).

Much of the reviewed literature suggests that there is a generational divide with regard to viewpoints on ICTs. However, some critics contend that this divide may not be as severe as it is often perceived to be. Still, there appears to be scant evidence that suggests that the older cohort is more proficient with ICTs in the workplace when compared to their younger counterparts. The CII RT 326 data set allows us to explore generational preferences towards specific ICTs (favorable or unfavorable). The academic and popular literature that supports the notion of a digital divide appears to be more prevalent than the critiques of it. This leads us to hypothesize: *Millennials view ICTs more favorably than Baby Boomers in the context of a virtual team*.

2.4. Methodology

As noted, we turned to the CII RT 326 survey on virtual teams in the construction and engineering sectors in an attempt to test this hypothesis. This survey was conducted as part of the effort to enhance the performance of virtual teams that work on construction and engineering projects. A total of 207 responses were gathered from the survey, which was originally distributed to approximately 1,386 industry professionals. The survey asked participants to identify their generation from among four choices – Millennials, Generation X, Baby Boomers, and the Silent Generation. The generational distribution of the survey participants is shown in Table 6.

Although the Baby Boomer and Millennial generation characterizations are commonly used in the United States to describe certain age cohorts, these designations are not always well-recognized outside of the United States. Therefore, participants who were working outside of the United States were removed from the sample prior to analysis. The remaining 84 Baby Boomer and 40 Millennial responses were analyzed for the purpose of our study (n=124). Table 7 shows the demographical makeup (in terms of their companies and positions) of the Millennial and Baby Boomer responses analyzed for this study.

Table 6 – Generation Distribution (n = 207)

Generation	Participants
Silent Generation (before 1946*)	3
Baby Boomers (1946-1964)	88
Gen X (1965-1980)	75
Gen Y or Millennials (1980-2001)	41

* The survey read "before 1946." However, the Silent Generation has been defined as having birth years ranging from 1928-1945 (Pew Research Center 2015a)

Table 7 – Company Information for Domestic Millenials and Baby Boomers (n=124)

Company Type	*Engineer/Contractor*	52%
	Private Owner	23%
	Public Owner	24%
Company Reach	*Local (in-state)*	1%
	Regional	3%
	National	6%
	Multinational	90%
Number of Employees	*<100*	2%
	100-500	3%
	501-1,000	12%
	1,001-5,000	17%
	50,001-10,000	15%
	10,001-50,000	16%
	>50,000	34%
Participants' Positions	*Project Engineer*	23%
	Project Management	29%
	Upper Management	15%
	None of the Above	32%

With regards to the 27 ICT abilities listed in Table 5, participants were asked to select one of five options to represent their assessment of the ICTs that may or may not be available in their organization:

a) Available and you use it

b) Available and you don't use it

c) Unavailable and you want to use it

d) Unavailable and you are not interested in using it

e) I don't understand what this is

Participants who selected option (e) were removed prior to the analysis of each ICT to ensure that the responses analyzed came from individuals who were knowledgeable about the specific ICT in question. The remaining responses were then grouped into "Favorable" and "Unfavorable" categories, with options (a) and (c) being considered "Favorable" and options (b) and (d) being considered "Unfavorable." Chi-squared tests were run on each of the ICTs to determine whether there were significant differences between the Millennial and Baby Boomer responses.

2.5. Results

The results for the analysis are displayed in Table 8. Two of the ICTs examined had expected values that were less than 5 in their chi-squared cells and are labeled accordingly. These results also show that none of the ICT categories had all significant or all non-significant relationships. All of the significant relationships that were found were for instances where Millennials had a more favorable opinion of the ICT in question.

Table 8 – Summary of Results

	ICT Ability	Millennials			Baby Boomers			
		Favorable	Unfavorable	Removed	Favorable	Unfavorable	Removed	p-value
Meeting/Collaboration	*Collaborate through web-based project workspace software*	29	7	4	59	17	8	0.7247
	Use the same collaboration technology across projects (e.g., all team members have equal access to technology)	39	1	0	65	14	5	0.0181*
	Use a project email system (e.g. Aconex)	25	12	3	53	23	8	0.8150
	Send instant messages to virtual teammates	36	4	0	62	22	0	0.0384*
	See virtual teammates	26	12	2	43	39	2	0.0995^{+}
	Notify virtual teammates when you wish to speak (e.g., virtually raise your hand)	22	15	3	50	25	9	0.4540
	Simultaneously collaborate virtually on documents	26	11	3	45	31	8	0.2536
	Virtually collaborate using mobile devices	30	7	3	43	37	4	0.0045**
	Tag key components during presentations (e.g., to come back with questions)	29	9	2	41	34	9	0.0251*
	Tell a virtual collaborator they have done a good job (e.g., virtual thumbs up)	26	12	2	43	32	9	0.2535
	Access multiple communication modes	33	3	4	51	18	15	0.0309*
	Hold impromptu conversations/meetings	38	2	0	62	16	6	0.0265*
Tracking/ Documenting	*Record/track/publish conversations*	29	11	0	38	40	6	0.0136*
	Provide transcripts from conversations	28	11	1	31	41	12	0.0038**
	Know which of your virtual teammates are currently online	33	7	0	57	27	0	0.0875^{+}
	Know how long your virtual teammates have been off-line	27	13	0	47	37	0	0.2204
	Check virtual teammate meeting availability	38	2	0	63	16	5	0.0283*
	Monitor and communicate project progress	37	3	0	62	15	7	0.0884^{+}
Information Sharing	*Share screens with annotation capability (e.g., for document/model reviews)*	26	13	1	45	36	3	0.2461
	Share screens	37	3	0	63	21	0	0.0211*
	Share files	40	0	0	72	11	1	0.0158§
	Share folders (e.g., Google Drive or ProjectWise or Dropbox)	36	4	0	69	12	3	0.4620
Other	*Remotely control another teammate's shared screen*	27	13	0	42	41	1	0.0769^{+}
	Simultaneously point to different elements when screen sharing	29	9	2	51	29	4	0.1723
	Make social media connections/postings	9	31	0	22	56	6	0.5050
	Reliably connect (e.g., bandwidth)	40	0	0	69	11	4	0.0139§
	Use encryption when transferring files over the Internet	28	10	2	47	27	10	0.2786

*$^{+}p<0.1$, *$p<0.05$, **$p<0.01$, § expected value(s) < 5*

2.6. Discussion

The results of this study reveal that roughly half of the ICTs from the CII RT 326 survey are viewed distinctly more favorably by the Millennials than by the Baby Boomers, which supports the notion of the digital native's better use of ICTs in the context of a virtual team. However, many of the ICTs analyzed did not appear to have generational views that differed significantly. The results of this study suggest that there is a digital divide between the older and younger generation, but this divide is only present in some ICTs. This section explores this finding further and discusses key points from the study results.

2.6.1. Meeting/Collaborating ICTs

This category, the largest of the four, included both insignificant and significant relationships. It appears that the Millennial participants valued the ability to hold impromptu meetings and conversations as well as the ability to send instant messages more favorably than the Baby Boomers. Interestingly, both these types of technologies are more informal and 'spur of the moment' in nature. Another ICT that relates to this informality is the ability to use mobile devices; mobile devices allow for text messaging (which can be considered a form of instant messaging). The younger generation is sometimes characterized as having an affinity for mobile phones, and this characterization is further supported by these results. The Millennials are often said to be more "collaborative" (Ferri-Reed 2014, p. 21), and this desire for collaboration may explain why half of the ICTs examined in this category exhibited significant differences. The results from this category of ICTs show that Millennials have a stronger preference for using ICTs for informal types of collaboration compared to their older counterparts.

2.6.2. Tracking/Documenting ICTs

This category of ICTs had by proportion the highest number of distinct differences between the generations in their views of the technologies. Only one of the six ICTs in this category had a p-value greater than 0.1, suggesting that these types of ICTs contribute to the digital divide. The Millennials viewed the ability to record/track/publish conversations as well as the ability to receive transcripts of these conversations more favorably than the older cohort. This may be because the Millennials are newer members of the workforce and may lack the background knowledge and experience needed to follow complex, work-related conversations. Therefore, they may prefer to reread meeting notes in order to gain a better understanding. This generation tends to look for "feedback" (Hershatter and Epstein 2010, p. 218), and this desire for feedback may also contribute to their desire to check teammate meeting availability, as suggested in the results. Clearer feedback can also be gained by reading transcripts of conversations.

2.6.3. Information Sharing ICTs

The desire for higher levels of collaboration and feedback may make the Millennials more willing to share information (such as in the forms of files or folders). However, there was no distinct difference observed in generational views on the ability to share folders. This ICT capability was deemed essential by the majority of respondents in both cohorts. This supports the findings of Vartiainen and Jahkola (2013), who reported that there were no complaints about FTP sites in their study. Both generations, by and large, agree that the ability to share files is a necessity in the context of a virtual team. Still, 11 of the Baby Boomer participants expressed unfavorable views regarding the ability to share files. This category of ICTs relates more to "information" rather than "communication." So it is possible that each generation has a similar

need for information in the context of a virtual team even if their preferred communication channels are not the same.

2.6.4. Other

This category, proportionally, had the least amount of significant differences between the Millennials and the Baby Boomers. Of the statistically insignificant ICTs in this category, the ability to make social media connections/postings is possibly the most surprising. This youngest generation is often associated with social media and their willingness to share issues with their "social networks" (Downing 2006, p. 5). However, the CII RT 326 survey is concerned specifically with workplace use of these ICTs, and the results suggest that Millennials do not care about social media capabilities in a work environment any more than Baby Boomers. This hints that the Millennials have a clear separation between work and leisure and supports suggestions by previous researchers that Millennials seek a good work-life balance (Baldonado 2013; Downing 2006).

2.6.5. Themes

The results of this study make it hard to make generalizations about the categories of the ICTs that different generations prefer. At first glance, there appears to be no pattern among the significant and insignificant relationships, but further examination reveals a theme running through a number of the significant relationships – informality. The Millennials tend to have distinctly more favorable views than the Baby Boomers regarding collaborating via more informal means with teammates. Another theme that is present in the results relates to the tracking of conversations. Millennials appear to value tracking and recording conversations more than the Baby Boomers. We think it is likely that Millennials prefer to keep better documentation

of meetings since they may lack experience and need to refer back to notes later to gain a better understanding of what was discussed during the meeting, but further research into the precise reason for the different generational views on meeting transcripts is clearly required.

2.6.6. Implications

Hamburg (2011) has noted that "the best software to use is the one the team/community is most familiar with and is most prepared to use" (p. 26). Malhotra and Majchrzak (2012) have found that virtual teams will benefit from working in a virtual workplace created by "virtual workspace tools" if more of these tools are provided to the team (p. 6:6). Hamburg stresses the quality of the tools provided, while Malhotra and Majchrzak stress the quantity of tools provided. The results from our study can inform the decisions of virtual team leaders concerning both the quantity and quality of ICT tools that should be provided to their team. Our results, in combination with Hamburg's (2011) proposition, will inform virtual team leaders regarding which ICTs their members view most favorably and thus allow them to limit their ICT tool selection to the ICTs that are most favored by both generations. Virtual team leaders can use our results in combination with Malhotra and Majchrzak's (2012) findings by designing team procedures that benefit from as many as possible of the favorably viewed ICTs. Using more favorably viewed ICTs in the context of a virtual team will allow for participants to communicate more effectively and may increase performance.

2.7. Limitations

This study categorized both the ICTs and response options after an existing survey was distributed; the survey was not developed with these explicit categorizations in mind. This limits the confidence level of the conclusions that can be drawn from each category. In addition, this

study was able to analyze only 124 responses; a larger sample size would greatly increase the confidence level of these results. The survey responses were all from professionals in the engineering and construction industries. This likely affected the results and limits the confidence when applying these findings to those working in other industries.

2.8. Conclusion

The results from this study help create a clearer picture of the digital divide and identify the ICTs for which this may be a particular problem. Although ICTs such as mobile phones appear to contribute to this divide, our results show that not all ICTs contribute to this divide such as the ability to share folders. Our results demonstrate that both the supporters and the critics of the existence of a digital divide may be justified in their views, depending on the ICTs being considered.

These results contribute to the literature by revealing exactly which ICTs (e.g., use of mobile phones) the older cohort lags behind in usage and help inform companies as to which ICTs should be the focus of training sessions to bring older cohorts up to speed with the Millennials. This study shows a more complete picture of the digital divide in virtual teams when compared to studies that focused on a single ICT. These results also reveal certain generational strengths that can be capitalized upon by efficiently distributing certain generations to specific tasks. The results of this study reveal that the Millennials did not have distinctly more unfavorable views than the Baby Boomers for any of the ICTs analyzed. Therefore, Millennials have a relative strength related to technology use when compared to their Baby Boomer counterparts when a broad range of ICTs are employed.

ENGINEERING SIGNIFICANCE

The studies prepared for this thesis have helped quantify the generational impact of virtual teams in the engineering and construction industries. The findings reveal and confirm specific strengths of generations in the context of a virtual team (e.g., Millennials being more skilled at handling time-distributed team members). The findings in this thesis also have important implications for virtual team leaders and designers. These findings will help virtual teams to better distribute their members to specific tasks that correspond with their generational strengths. This thesis fills a part of a large gap in the virtual team literature. This thesis is only the beginning of generational studies in the context of virtual teams and provides a foundation for future research on this topic. The research performed in these studies demonstrates that the Millennials have relative strengths in the virtual team environment when compared to their Baby Boomer counterparts

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APPENDIX A – Analysis Details and Data Management

Study #1

Procedure:

1. Data was downloaded for specific questions (8.5, 8.7, 8.8, 8.9, 9.7, 9.10, & 9.14) from Tier I of Construction Industry Institute Research Team 326 survey. Survey data was stored on virginiatech.qualtrics.com and was downloaded into a Microsoft Excel file.
2. Questions were renumbered for clarity.
    a. 8.8 = Q1
    b. 8.9 = Q2
    c. 9.14 = Q3
    d. 8.7 = Q4
    e. 9.10 = Q5
    f. 8.5 = Q6
    g. 9.7 = Q7
3. Questions were assigned to hypotheses.
    a. H1: Q1, Q2, Q3
    b. H2: Q4, Q5
    c. H3: Q6, Q7
4. Participants were removed who indicated they were part of Generation X and the Silent Generation in Question 10 of the original Tier I survey.
5. Participants were removed who completed the survey outside of the United States by using their IP address.
6. Likert scale responses were assigned integer numbers (Strongly Agree = 5, Agree = 4, etc.)

7. Using the statistical software package JMP, an F-test for unequal variance was run for the responses of the remaining participants for the seven questions.
8. Based off of the results of the F-test for unequal variance, pooled (opposed to unpooled) one-tailed t-tests were performed in JMP on Q1-Q7 to examine the differences in the means between the two remaining generations ($H_a = \mu_{Millennials} < \mu_{Baby\ Boomers}$). A p-value of 0.05 was set to determine significance.
9. Cronbach's alpha was calculated for the questions using JMP to assess reliability.

Data Management:

Samuel Ferrara was added to the Virginia Tech Institutional Review Board (VT IRB) data protocol #14-1022 – CII RT326: Maximizing the Performance of Virtual Teams in the Engineering and Construction Industry as a co-investigator prior to being given access to the data set. The VT IRB approval letter has been submitted as an additional attachment to this thesis.

Raw Data:

Per VT IRB requirements, the raw data has not been included in this thesis.

Study #2

Procedure:

1. Data was downloaded for Question 4 from Tier I of Construction Industry Institute Research Team 326 survey. Survey data was stored on virginiatech.qualtrics.com and was downloaded into a Microsoft Excel file.
2. Participants were removed who indicated they were part of Generation X and the Silent Generation in Question 10 of the original Tier I survey.
3. Participants were removed who completed the survey outside of the United States by using their IP address.
4. Each of the 27 sub-questions were categorized into one of the following categories:
    a. Meeting/Collaborating
    b. Tracking/Documenting
    c. Information Sharing
    d. Other
5. For each of the 27 sub-questions:
    a. Responses for "Available and you use it" and "Unavailable and you want to use it" were grouped together into a "Favorable" category.
    b. Responses for "Available and you don't use it" and "Unavailable and you are not interested in using it" were grouped together into an "Unfavorable" category.
    c. Responses for "I don't understand what this is" were removed and not considered in the analysis.
6. Using the statistical software package JMP, chi-squared tests were run on each of the 27 sub-questions to determine if there was a statistically significant difference between the

number of favorable and unfavorable responses of the Millennials and the Baby Boomers. A p-value of 0.05 was set to determine significance. However, p-values of 0.1 or less were considered to be approaching significance.

7. Sub-questions that had expected values less than 5 were noted and p-values were not considered to be accurate for these questions.

Data Management

Samuel Ferrara was added to the Virginia Tech Institutional Review Board (VT IRB) data protocol #14-1022 – CII RT326: Maximizing the Performance of Virtual Teams in the Engineering and Construction Industry as a co-investigator prior to being given access to the data set. The VT IRB approval letter has been submitted as an additional attachment to this thesis.

Raw Data

Per VT IRB requirements, the raw data has not been included in this thesis.

APPENDIX B – Survey

Study 1

Question 8:

Q8 How challenging is _____ in virtual team collaborations (in your organization)?

	Not Challenging	Less Challenging	Challenging	Somewhat Challenging	Very Challenging
reading non-verbal cues	❍	❍	❍	❍	❍
absence of collegiality	❍	❍	❍	❍	❍
establishing rapport and trust	❍	❍	❍	❍	❍
understanding the overarching project goals	❍	❍	❍	❍	❍
the use of virtual technologies	❍	❍	❍	❍	❍
the sense of isolation	❍	❍	❍	❍	❍
dealing with different time zones	❍	❍	❍	❍	❍
dealing with different languages	❍	❍	❍	❍	❍
dealing with different cultures	❍	❍	❍	❍	❍
building relationships	❍	❍	❍	❍	❍
managing conflict	❍	❍	❍	❍	❍
participation among colleagues	❍	❍	❍	❍	❍
leadership	❍	❍	❍	❍	❍
making decisions	❍	❍	❍	❍	❍
expressing opinions	❍	❍	❍	❍	❍
generating innovative ideas	❍	❍	❍	❍	❍

Question 9:

Q9 In your experience, to what extent do you agree that the following items are barrier(s) to effective virtual teams?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Software license are unavailable	❍	❍	❍	❍	❍
Cost prohibitive virtual team technologies	❍	❍	❍	❍	❍
Network security/firewalls	❍	❍	❍	❍	❍
Lack of IT processes and procedures	❍	❍	❍	❍	❍
Inadequate hardware	❍	❍	❍	❍	❍
Difficulty with technology implementation	❍	❍	❍	❍	❍
Inadequate management support	❍	❍	❍	❍	❍
Poor connectivity	❍	❍	❍	❍	❍
Time difference between distributed team members	❍	❍	❍	❍	❍
Adoption resistance	❍	❍	❍	❍	❍
Cultural/language differences	❍	❍	❍	❍	❍
Generational differences	❍	❍	❍	❍	❍
Differences in individual technology preferences	❍	❍	❍	❍	❍
Lack of social interaction	❍	❍	❍	❍	❍
Difficulty in interpretation of social cues (e.g., tone, inflection, etc.)	❍	❍	❍	❍	❍
Incompatibility between software systems	❍	❍	❍	❍	❍
Site safety procedures/requirements (intrinsically safe)	❍	❍	❍	❍	❍
Prohibitive physical or information security requirements	❍	❍	❍	❍	❍
Overly restrictive software requirements	❍	❍	❍	❍	❍
Uneven participation at virtual meetings	❍	❍	❍	❍	❍

Lack of virtual team training	❍	❍	❍	❍	❍
Lack of trust	❍	❍	❍	❍	❍
Infrequency of communication	❍	❍	❍	❍	❍
Inability to track team members' work progress	❍	❍	❍	❍	❍

Study 2

Question 4:

Q4 We would like to understand the current virtual collaboration technologies and features actively in use by your organization on virtual teams.
Please select all technical capabilities that are: (1) available to you and you use them, (2) available to you but you don't use them, (3) that are not available to you but you would like to use them, (4) or not available to you and you are not interested in using them. If you do not understand the technical capability please indicate so by selecting: (5) "I don't understand what this is."

	Available and you use it (1)	Available and you don't use it (2)	Unavailable and you want to use it (3)	Unavailable and you are not interested in using it (4)	I don't understand what this is (5)
Ability to send instant messages to virtual teammates	❍	❍	❍	❍	❍
Ability to know which of your virtual teammates are currently online	❍	❍	❍	❍	❍
Ability to know how long your virtual teammates have been off-line	❍	❍	❍	❍	❍
Ability to make social media connections/postings	❍	❍	❍	❍	❍
Ability to share screens	❍	❍	❍	❍	❍
Ability to remotely control another teammate's shared screen	❍	❍	❍	❍	❍
Ability to share screens with annotation capability (e.g., for document/model reviews)	❍	❍	❍	❍	❍
Ability to collaborate through web-based project workspace software	❍	❍	❍	❍	❍
Ability to share files	❍	❍	❍	❍	❍
Ability to share folders (e.g., Google Drive or ProjectWise or Dropbox)	❍	❍	❍	❍	❍
Ability to use a project email system (e.g. Aconex)	❍	❍	❍	❍	❍
Ability to see virtual teammates	❍	❍	❍	❍	❍

Ability to reliably connect (e.g., bandwidth)	❍	❍	❍	❍	❍
Ability to notify virtual teammates when you wish to speak (e.g., virtually raise your hand)	❍	❍	❍	❍	❍
Ability to use the same collaboration technology across projects (e.g., all team members have equal access to technology)	❍	❍	❍	❍	❍
Ability to record/track/publish conversations	❍	❍	❍	❍	❍
Ability to have transcripts from conversations	❍	❍	❍	❍	❍
Ability to simultaneously collaborate virtually on documents	❍	❍	❍	❍	❍
Ability to simultaneously point to different elements when screen sharing	❍	❍	❍	❍	❍
Ability to check virtual teammate meeting availability	❍	❍	❍	❍	❍
Ability to virtually collaborate using mobile devices	❍	❍	❍	❍	❍
Ability to tag key components during presentations (e.g., to come back with questions)	❍	❍	❍	❍	❍
Ability to tell a virtual collaborator they have done a good job (e.g., virtual thumbs up)	❍	❍	❍	❍	❍
Ability to access multiple communication modes	❍	❍	❍	❍	❍
Ability for encryption when transferring files over the Internet	❍	❍	❍	❍	❍
Ability to have impromptu conversations/meetings	❍	❍	❍	❍	❍
Ability to monitor and communicate project progress	❍	❍	❍	❍	❍

APPENDIX C – Student's Contribution

** *This appendix is required by the Civil and Environmental Engineering Department.*

Samuel Ferrara received the already collected survey data from CII RT 326. He conceived the idea for both studies and performed the analysis. He received advising from his committee members and Neda Mohammadi (co-author). Samuel wrote all sections of both studies. He received periodic comments from committee members and Neda Mohammadi and incorporated those comments into the paper as he saw fit.