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Virtual Project Team Performance

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Abstract

Virtual Project Team Performance

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The use of Virtual Teams has become substantially more common place as the "global economy" has grown. Technology has enabled teams to collaborate across time and space, but can these teams perform as well or better than their co-located peers? The answer to this question is critical for companies considering offshoring or near shoring specific job functions. This question is also important for companies that require specialized resources that are unavailable in the local market place. The cost of relocating and centralizing specialized resources can be high and can be altogether avoided if virtual team performance is high. This paper addresses the performance question, discusses contingency factors impacting performance, and provides recommendations based both on the research and real world experience of the author.

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Chapter 1: Introduction

PURPOSE

The world is flat. Or at least it is much flatter than it used to be. Over the past several decades, there have been significant changes in information and communication technologies that have contributed to this phenomenon. According to Thomas Friedman, the author of *The World is Flat*, the world has been flattened by ten "flatteners": The opening of the Berlin Wall, Netscape going public, workflow, outsourcing, offshoring, open-sourcing, insourcing, supply-chaining, in-forming (search engines), and "the steroids" such as personal digital devices that amplify the other flatteners (Friedman, 2005, p. 8). The new, "flatter" world has changed the dynamics of the modern work force. Terms such as "virtual worker", "teleworker", and "telecommuter" have become commonplace. This paradigm shift in the way businesses operate also requires a different type of manager—the distance manager. One could argue that distance managers have been around for centuries. As Fisher & Fisher point out, a vast array of historical leaders including Julius Caesar, Alexander the Great, Napoleon Bonaparte, Joan of Arc, and Paul the Christian apostle all led from afar. They did so without computer mediated communication technologies (2001).

Cramton indicates a need for the study of distance management and virtual teams, "*our use of such teams has outpaced our understanding of their dynamics, and inexplicable problems have been noted*" (2001, 346). This perception is supported by others who note that most of today's management science harkens from the Industrial Age (Lipnack, Stamps, 2000). The rigid, hierarchical, and bureaucratic structures from this era must make way for the flatter, agile approaches of today's virtual team. For the

purpose of this thesis, we define a virtual team (VT) as "a group of individuals who work interdependently across space, time, organizational boundaries, and/or work practices through the use of collaboration technology to accomplish shared goals" (Duarte, Snyder, 2006). This thesis focuses on the various dynamics that impact VT performance as well as the management practices that enable these teams to perform well. Thus the primary question of this thesis is:

Can virtual project teams perform at levels equal to or greater than co-located teams? If so, on what contingency factors do virtual team performance depend?

This document outlines the major challenges and management issues surrounding the people, processes, and technology involved in virtual teaming, and explores possible answers to this question.

STRUCTURE OF THESIS

This thesis proposal is structured into 4 chapters. Chapter 2 reviews the current literature on virtual teams and virtual team management. Chapter 3 presents five cases studies used for secondary research, and uses cross case analysis to address the thesis question. Finally, chapter 4 presents the conclusion and presents recommendations for the virtual project team leader.

Chapter 2: Literature Review

The most common research available on virtual teams is the result of student-based studies. An example of this type of study is where a graduate class in Management at University A is given an assignment to work with a similar group at University B. The universities usually have a significant distance between them. The groups are given a collective goal (i.e. develop a business plan for a new company), and they are usually provided with a base set of technologies to collaborate with. In many cases, the technology used to collaborate captures all of the electronic communication and provides the researchers with a rich set of data to analyze.

The other (less common) type of research is more "field based" where researchers engage companies that have a distributed work force. The researchers typically develop surveys and interview employees that have worked on virtual teams. Another approach is reviewing project management artifacts from projects that utilized virtual project teams.

This chapter discusses the overall advantages and disadvantages of virtual teams, and reviews management issues within the following categories: people, processes, and technology.

ADVANTAGES

Longer Work Day

With a co-located team, standard work hours are usually 8-10 hours. However, a virtual team dispersed across time zones can extend the amount of work hours in one day substantially (Payton, 2010). This could lead to substantially more productivity in project-based organizations. For example, a quality assurance team based in New Delhi

can complete a full day of testing before the software development group in Dallas, TX starts the day. This same benefit can also produce challenges. Those issues are discussed later in this this chapter. According to Gartner research, almost every industry can benefit from virtual workers (Jones, 2006). The industry sectors that are most appropriate are banking and finance, insurance, business services, healthcare, the voluntary sector and some government departments.

HR - Larger Resource Pool

Virtual employees give the organization the benefit of recruiting and retaining the best employees even though they may live far away or are unable or unwilling to commute (Hill, Ferris, Martinson, 2003). According to Dr. Shervani at the University of Texas, the need for knowledge workers in the United States will far outweigh the supply by 2020. Countries with a surplus (i.e. India, China, Mexico, South America, etc.) will provide these resources. (Shervani, 2005)

HR - Lower Operational Costs

In recent years, many companies have centralized operations which have resulted in the closure of field offices. Instead of incurring all of the direct costs associated with terminating employees (i.e. exit interviews, accrued vacations, continued benefits, recruiting, selection, and hiring costs), decisions were made to offer key employees telecommute options. The businesses were still able to gain cost efficiencies by closing offices, but they were able to retain knowledge workers. (Hill et al, 2003).

DISADVANTAGES

Communication

Virtual relationships often lack the nonverbal communication opportunities that are present in face-to-face relationships. For that reason, the level of communication

across virtual teams must increase exponentially. The team leader ought to encourage 360-degree communication across the team, and it is the responsibility of everyone on the team to ensure this is happening (Malone, 2004). Time zone gaps (temporal) and technology issues present communication problems as well. Significant gaps in time zones between locations can present challenges in hours that virtual team members can meet or correspond in "real-time" via email. Charles McLeod, Price Water House Cooper's director of global outsourcing said that "*I get to my office at 9am and ask my virtual team questions that I know they won't answer until after lunch—and some answers won't come through until after my day is done.* " (Payton, 2010,16)

In a case study presented by Catherine Cramton, graduate business faculty and students at nine universities on three continents worked on a collaborative project. Each six-member team had pairs from two U.S. schools and one university elsewhere. The 13 teams had students that were from the United States, Canada, Columbia, Portugal, Germany, Ukraine, India, Thailand, Hong Kong, and Indonesia. The seven-week project's scope was for the students to develop a business plan that required use of the internet, to write a business plan, and to develop a presentation for investors or a web-based storefront. Communication tools used by the team members included e-mail, internet based "chat" tools, a web-based voting tool, telephone, and fax. Significant conflicts arose during the project period and a large portion of the issues revolved around communication. The lack of consistent "mutual knowledge" was attributed to five major factors: lack of contextual information, uneven distribution of information, differences in salience of information, relative speed of access, meaning of silence uncertain, and technical problems. (Cramton, 2001).

Retention.

Although retention is considered a benefit of virtual teams, it can also be a disadvantage. While poaching of employees has always been a problem with co-located teams, this issue is applicable to dispersed teams as well. "*It is hard to prevent this from happening when your employees are all the way across the globe*," says Martin McGrath, head of restructuring at Grant Thornton (Payton, 2010). Although this may be a disadvantage, it is offset by the advantage of having a global resource pool to recruit from.

Trust

Distrust is an issue that companies employing virtual employees must work through. Employees working inside the brick and mortal organization may have level of resentment and distrust towards their virtual colleagues. Also, the virtual workers have concerns with feeling "out of sight, out of mind" which may hamper career advancement (Fiering, 2009). Trust is important because it keeps communication between team members efficient. Without trust, team members will spend additional time second guessing and validating the content of message exchanges (Furumo, Pearson, 2007). Managers also have a distrust of employees that cannot be seen and directly controlled (Fiering, 2009).

Possible solutions to the trust issues include building early, "swift trust" (Jarvenpaa, Leidner, 1999). In globally dispersed teams, Jarvenpaa et al. indicate the importance of establishing healthy communication patterns early (1999). Fiering recommends putting corporate policies and procedures in place to support the virtual employee. Otherwise, a "mercenary" environment is created where the virtual employee feels the need to work for them self, rather than the company (Fiering, 2009). Some of these policies and procedures are discussed in the "Processes" section of this chapter.

Fiering (2009) also notes that teleworkers must make extra efforts to be "seen" through their actions.

Work/Life Balance

For the virtual teams that include telecommuters, a challenge some of these team members face is the ability to define and maintain the boundaries between work and home. IBM conducted a study in 2001 to determine the impact of "telework" on aspects of both personal/family life and career (Hill, et. al, 2003). IBM produced an online survey that invited 59,250 (25,822 responses) employees to rate the impact of telework on various aspects of work and personal/family life. The teleworkers were divided into two separate categories: virtual office, and home office. The virtual office employees were mobile and did not have a permanent work location. These employees also had company supplied pagers and cellular phones. The home office employees had dedicated locations within their homes to perform the work. This split resulted in slightly different responses with regards to the impact of work on personal/family life. Virtual office workers responded with lower ratings on the work/life balance questions than did the home office worker. However, Hill et al. (2003) indicate that the primary implication is that the virtual office workers have not created boundaries between work and home, and that their employer ought to provide adequate training on ways to balance work/life issues.

PEOPLE

Virtual Organization Structures

Leadership responsibilities are different across virtual teams. In contrast to the standard hierarchical process, it is common for this responsibility to be shared across the

virtual team. (Weisband ,2007) This type of rotation is not necessarily indicative of an efficient operation. There are situations where the emerging leader may take charge in response to a poorly run team (Hollander, Julian, 1969). Leadership structures that virtual teams use range from permanent leaders, to rotating leaders, to either a leaderless structure or one assisted by a facilitator or coordinator (Nemiro, Beyerlein, Bradley, Beyerlein, 2008).

Virtual Leader Characteristics

Effective leadership is the number one factor that influences success in a virtual organization (Lockwood, 2010). Characteristics of a virtual team leader include "cultural dexterity", emotional intelligence, and sensitivity (Payton, 2010). According to Fisher and Fisher, the virtual leader is not a supervisor. The ability to manage someone that you do not see is very different than "*walking around the cubicle wall to see if they're there at eight in the morning."* (2001, 272) Additionally, virtual leaders do not perform the traditional command and control role. They coach remote employees on how to control themselves while virtual leader focuses on "boundary management." This is simply empowering the team members to self-manage all of the processes required for optimal performance while the team leader focuses on managing the external environment (competitors, technologies, headquarters, economic changes, vendors, customers, etc.) (Fisher & Fisher, 2001). The virtual leader is very adept at conflict resolution (Lockwood, 2010). All leaders have varying levels of conflict to manage, but distributed teams can make this skill much more critical. Other characteristics of the leader role include reliability, consistency, responsiveness, and ethical integrity (Gibson, Cohen, 2003).

Cultural Diversity

Cultural background plays a factor in the performance of individuals in a virtual environment. The preference in some cultures to consider the individual first and then the team may cause those who have grown up in a more collective or group-oriented society (i.e. Asia) to feel uncomfortable with the independence of teammates (Duarte et. al, 2006).

A common best practice is to discuss and leverage team member diversity. Some virtual team leaders use personality assessment tools such as Myers-Briggs, DISC, etc. to understand the ways their employees are motivated. One article discusses the use of this within a meeting setting. At the early onset of the team, people often reminded others of their personality type before they spoke. This helped people to appreciate the diversity of their colleagues and to avert possible misunderstandings during the critical, formative phase of the team (Majchrzak et. al,2004). Many companies, such as Shell Chemicals, use online collaboration portals to facilitate knowledge transfer and to help team members appreciate diversity. Shell created a virtual work area for various projects. The virtual work area had a section dedicated to the team members that kept contact information and extensive profiles that included photographs, accomplishments, areas of expertise, and interests (Majchrzak et. al, 2004). The availability of tools such as Microsoft SharePoint and the various social media tools (i.e. Facebook, Twitter, MySpace, etc.) make this type of collaboration feasible for most virtual teams.

PROCESSES

Meetings

Both virtual and co-located teams function more efficiently with well-defined processes and procedures. Co-located teams can often get away with "just enough"

policies and procedures to function, but research shows that virtual teams must have very well defined policies and procedures to operate. In particular, meetings must be planned and managed very carefully. Gartner research states that a "cardinal rule" of virtual teaming is to bring the team together face to face at the beginning of a project or effort (Bell, 2002). However, Staples and Zhao (2006) contend that this is only beneficial if the team is homogeneous from a cultural perspective. Otherwise, they believe that the salient differences in the team could harm the initial development of the team. Instead, they recommend meeting after the team has established an identity. Collaborative technologies can reduce the impact of such diversity early on (Staples et. al, 2006). If a face-to-face meeting is cost prohibitive, a secondary recommendation is to setup a videoconference allowing people to visit members visually and to associate faces with names. Since team members are not in the room with one another, the leader needs to keep the meeting on track and manage it like a "highly orchestrated event." Poor planning for co-located meetings is often okay, but this is not an acceptable practice for virtual team meetings. Poor planning requires additional meetings to fill in the gaps (Malhotra, Majchrzak, Rosen, 2007). A challenge in running meetings for both virtual and co-located teams is keeping team members engaged. However, this is more pronounced for virtual meetings. Malhotra mentions a case where one team leader had an online "check-in" technique he used to keep team members engaged. Frequently, he would conduct polls and solicit immediate feedback from team members while meetings were in session (Malhotra et. al, 2007).

Performance Management

Performance management processes must be carried out consistently across countries. Tata Consulting, a large technology consulting company in India does not perform verbal reviews. An online software application is used instead. (Payton, 2010).

In addition to annual reviews, a best practice is to publish balanced scorecard measurements in the team's virtual workspace (Malhotra et. al, 2007). This aligns with other books and/or articles that discuss moving from a "face-to-face" culture to "results oriented" business culture (Hill et. al,2003),(Malhotra, et. al), (Lockwood, 2010). A common misconception is that virtual employees need to be able to produce without the feedback loops afforded to co-located teams. The virtual team leader provides very explicit guidelines to team members with regards to issues which they must be informed, and how decisions will be made. Virtual team leaders never assumes that team leaders will "figure out what to do" without clear direction (Duarte, Snyder-2006).

HR Policies

According to Duarte, et. al human resource policies ought to support working virtually. Systems must be integrated and aligned to recognize, support, and reward the people who work on and lead virtual teams (Duarte et. al, 2006). Also, HR groups should establish selection, development, and training programs for virtual teams. It could be argued that the knowledge, skills, and abilities needed for virtual team members are the same as co-located. However, the nature of virtual teams highly underscores the importance of skills such as "*tolerance and understanding of diverse viewpoints, interpersonal and team skills requiring new forms of communication and information sharing, self-regulatory skills, and high levels of comfort with technology hardware and software for managing virtual tasks*" (Gibson, Cohen, 2003, 416).

Processes That Push Performance Up to and Beyond Co-located Levels

According to a study by Frank Siebdrat, Martin Hoegl, and Holger Ernst (2009) virtual team processes are categorized in two major categories:

(1) Task oriented – ensure team members are contributing at the highest levels.

(2) Socio-economic – tasks that increase cohesiveness of the team.

Teams that maximize these processes may outperform co-located teams (Siebdrat, Hoegl, Ernst, 2009). This case is discussed in more detail in Chapter 3.

TECHNOLOGY

The technology choices for communication across virtual teams have expanded greatly in recent years due to the advancement of Internet based technologies. Video conferencing, phone (voice over IP), instant messaging, email, wikis, collaboration portals, and quickly immerging social media tools provide endless means to collaborate. When used to facilitate meetings, Duarte and Snyder (2006) note that these tools ought to be used to serve meetings, not dominate them. In particular, this author has witnessed several meetings suffer from technology glitches when other technology choices would have served the meeting just as well. For example: there have been several times when the better part of an hour was spent getting mal-functioning video configured when a standard phone call or web-ex would have been more appropriate for the meeting agenda. Another example of using the appropriate technology for the collaboration required is the use of email. Email is a very poor tool for collaboration when a high level of input is required from the team (Majchrzak et. al, 2004). The lack of version control is a major problem. It is difficult enough for multiple users to stay on the same message thread, but this is compounded when a group is working on a shared document. Also, the standard of carbon copying everyone on the email thread forces can lead to undesired behaviors such as recipients deleting messages without reading them (Majchrzak et. al, 2004). To assist with deciding on a technology to task fit, Duarte and Snyder propose a technology selection process based on the meeting interaction continuum:

Figure 1 - Meeting Interaction Continuum (adapted from Duarte/Snyder, 2004)

Information Sharing	*Brainstorming and Decision Making*	*Collaborative Work*
Low Interaction	**Moderate Interaction**	**High Interaction**
Voice mail	Electronic bulletin board	Real-time data conference (i.e. Web-ex, Goto Meeting)
Email	Chat rooms	White boards with audio/visual link
	Videoconference	Electronic Meeting System (EMS) with audio/video and text for graphics.
	Audio conference	Collaborative writing tools with audio/video links
	Real-time data conference (i.e. Web-ex, Goto Meeting)	

In addition to the formal communication channels, channels for informal "virtual water cooler" conversation ought to be created as well. The purpose is to create a mechanism for members to informally share information and perspectives about what is going on with regard to individuals on the team or the team's work. (Malone, 2004). Tool such as "Yammer" are used by virtual teams to serve this purpose (Chafkin, 2010)

EMERGING RESEARCH

The majority of the available virtual team research discusses the previously discussed issues. However, there is emerging research in areas such as the impact of

geographic configuration, and gender on team performance. These are briefly discussed in this section.

Geographic Configuration and Subgroups

Geographic configuration is defined as the number of geographically dispersed teams (GDTs) and the relative number of team members at those sites, independent of the spatial, temporal, and socio-demographic distances between them (O'Leary, Mortensen, 2010). In the O'Leary, Mortenson study, three types of configurations identified were (1) balanced subgroups – equal team sizes (2) imbalanced subgroups – teams with differing sizes, and (3) isolates - singletons. Subgroups were defined as two or more team members per site. Another key term described in the study is "Transactive Memory." Transactive memory is a term introduced by Daniel Wegner that describes the ability of teams to understand who knows what in the group (Wegner, 1986). Another way to think about the concept is to consider that each member has a mental index of what others in the group know and understand. O'Leary and Mortenson observe the following:

1. Teams with subgroups perform more poorly than those without them on the four key dimensions (identification, transactive memory, conflict, and coordination problems)
2. Teams with subgroups had significantly lower transactive memory than non-subgroup teams.
3. Teams with subgroups had higher conflict than non-subgroup teams.
4. Teams with subgroups had significantly more coordination problems than teams without subgroups.
5. Members of minority subgroups had more problems than those with majority subgroups. Teams with geographic minorities reported lower identification

and transactive memory than non-minorities. They also reported more coordination problems than their nonminority counterparts.

6. Teams with isolates reported higher identification, more effective transactive memory, lower conflict, and better coordination than teams with balanced or imbalanced subgroups.

Gender Impact on Virtual Teams

There are several studies on the impact of gender with co-located groups, but this area has far less coverage within the context of virtual teams. Perhaps the reasoning lies in the fact that most of the research available contends that distributed teams neutralize gender impact. According to Chattopadhyay, George, and Shulman, "*Sex dissimilarity was found to have a stronger influence on work group identification, and task and emotional conflict in co-located work groups than in distributive work groups*." (2008). This concept was supported by Furumo and Pearson's research. They indicated that males had less ability to dominate team interaction and that the electronic communication mediums "equalized" the communication between male and female team members (Furumo, Pearson, 2007). Trust is a major contributor to the success of the virtual team. Although prior research has indicated that both virtual and co-located teams begin initiatives with a high-level of trust ("swift trust"), Furumo et al. hypothesized that women would report higher levels of trust and satisfaction than males in short-duration virtual teams. They performed an experiment that measured perceived trust levels and satisfaction. The study involved 102 upper level college students (64 male, 38 female, mean age:22) enrolled in a management course at a mid-sized university in the Midwestern United states. At the end of the effort, students were given survey that measured the levels of perceived trust and satisfaction in the team. The results showed

that the women had a slightly higher trust level than the men, and that satisfaction levels among men and women were about the same (Furumo, et al, 2007). Research conducted by Mary R. Lind countered the conclusion that team satisfaction levels are equal between men and women. Lind's research concluded that women had higher satisfaction levels than men. A possible reason for this is the previously mentioned equalizing effect of the technology used for the inter-team communications (Lind, 1999). One implication of this study is that women might make better leaders of virtual teams at the onset of project initiatives. Although this emerging topic is out of scope for this thesis, it should be considered (alongside the other emerging topics) when putting together a virtual team.

Chapter 3: Study Methodology

This chapter looks at five case studies that compare the performance of virtual and co-located teams. The results are discussed and the chapter closes with a cross case analysis.

1 - An Investigation of the Use of Global, Virtual, and Co-located New Product Development Teams

The goal of this study was to understand the differences in co-located, virtual, and global teams for New Product Development (NPD) and to what extent each type faced behavioral and project management issues. Also, the study focused on the performance of each team type. The researchers defined the differences in team types as follows:

- **Co-located NPD teams** are comprised of individuals who work together in the same physical location and are culturally similar.
- **Virtual NPD teams** are comprised of individuals who have a moderate level of physical proximity and are culturally similar. One example of a virtual team is where team members are located in different parts of the same country.
- **Global NPD teams** are comprised of individuals who work and live in different countries and are culturally diverse.

The researchers also proposed the following:

- P1: Greater behavioral challenges are associated with lower project performance.
- P2: Global teams face a greater degree of behavioral challenges than either co-located or virtual teams.

- P3: Greater project management challenges are associated with lower project performance.
- P4: Global teams face a greater degree of project management challenges than either co-located or virtual teams.
- P5: Global teams will be associated with lower performance than either co-located or virtual teams.
- P6a: Type of team will moderate the relationship between behavioral challenges and performance.
- P6b: Type of team will moderate the relationship between project management challenges and performance.

The researchers developed a three-page questionnaire that focused on the usage, challenges, and performance of co-located, virtual, and global teams. The questionnaire was randomly distributed to members of the Product Development and Management Association (PDMA). Out of 1156 members that received the survey, 103 surveys were completed and returned.

To determine the usage for co-located, virtual, and global NPD teams, respondents were asked to answer the question, "Please distribute 100 percentage points across the three team categories for each given time period: % used 5 years ago, % used in the past twelve months, and % that will be used 3 years from now."

Behavioral and project management challenges were measured by a series of questions that asked respondents to rate the extent to which they had experienced eight types of challenges. The three items used to measure behavioral challenges were:

(1) Generating trust between team members

(2) Achieving effective interpersonal relationships

(3) Achieving effective communication among team members

The five items used to measure project management challenges included:

(1) Identifying customer needs

(2) Ensuring goals remain stable

(3) Keeping on schedule

(4) Having sufficient resources

(5) Staying on budget

A five-point scale where 1 equaled "not at all", and 5 equaled "to a great extent" was used. The respondents were asked to answer the questions for each of the three different team types (virtual, global, or co-located) they had in their organization.

Results

Table 1 – Usage of Co-located, Virtual, and Global NPD Teams

Team Categories	% of each type of team used 5 yrs ago	% of each type of used in the past 12 mos.	% of each type of team that will be used 3 yrs from now
Co-located NPD	38	37	35
Virtual NPD	56	49	41
Global NPD	4	14	22
Table adapted from the McDonough III et. al study (McDonough III et. al, 2001)			

Table 2 - Comparing Mean Values for Behavioral Challenges, Project Management, and Performance Across Co-located, Virtual, and Global NPD Teams

	Behavioral Challenges	Project Management Challenges	Performance
Co-located Teams	2.22 (sd = .78, n= 75)	2.74 (sd = .76, n=74)	3.38 (sd = .69, n=73)
Virtual Teams	3.07 (sd = .76, n=89)	3.16 (sd = .79, n= 88)	3.05 (sd =.65, n=86)
Global	3.49 (sd = .94, n = 52)	3.24 (sd = .84, n=51)	2.75 (sd = .82, n = 46)
SS between groups	55.07 (df = 2)	9.79 (df=2)	11.62 (df=2)
SS within groups	141.69 (df=213)	131.22 (df=210)	100.04 (df=202)
F	41.39	7.83	11.73
Significance	.000	.001	.000
Post-hoc Scheffe Test	Co-located <*** Virtual <** Global	Co-located <*** Virtual, Global	Co-located > *** Virtual > * Global
Key for Post-hoc Scheffe Test: *** = p <.01, **, ** = p <.05, * = p < .10			
Table adapted from the McDonough III et. al study (McDonough III et. al, 2001)			

Table 3 - Proposition Results

Proposition:	**Results:**
P1: Greater behavioral challenges are associated with lower project performance.	Not supported by results
P2: Global teams face a greater degree of behavioral challenges than either co-located or virtual teams	Supported by results
P3: Greater project management challenges are associated with lower project performance.	Supported by results
P4: Global teams face a greater degree of project management challenges than either co-located or virtual teams.	Partially supported by results
P5: Global teams will be associated with lower performance than either co-located or virtual teams.	Supported by results
P6a: Type of team will moderate the relationship between behavioral challenges and performance.	Not supported by results
6b: Type of team will moderate the relationship between project management challenges and performance.	Not supported by results

Discussion

Unlike much of the existing literature on the topic, this particular study made the distinction between a virtual team and a global team. While a virtual team has dispersed members of the team that are separated by time, distance, and culture; the global team's differences in these categories are usually more pronounced. The survey showed that usage of both co-located and virtual teams is decreasing while the use of global teams is increasing over time. However, both global and virtual teams are considered virtual from

this thesis author's perspective, so the research indicates that the use of co-located teams is decreasing while virtual teams are increasing in usage. The researchers in this study followed up with respondents to understand the increase in global team use. The respondents noted that company resources were dispersed, and that it was not feasible to centralize the resources.

The study shows that co-located teams perform better than both virtual and global teams. Virtual and global teams experience a higher degree of project management issues and consequently, performance suffers. McDonough et al. also shows that the project management issues experienced by global and virtual teams are statistically the same. However, behavioral challenges were statistically different across the three team types. Although this particular study was unable to illustrate a causal link between behavioral issues and team performance, the virtual team manager should still consider behavioral issues when leading a team. McDonough et al. suggest that perhaps the gap in illustrating the linkage is due to the senior level of the respondents to the survey (vice president/director level). These senior level employees may not have heavy enough involvement in day-to-day activities to appreciate behavioral issues that may actually exist (McDonough et al., 2001). Further investigation may discover an impact on project management challenges, which has an impact on performance. This is the opinion of this thesis author and is based on real world experience.

2 - A COMPARISON OF FACE-TO-FACE AND VIRTUAL SOFTWARE TEAMS

A study developed by Hayward P. Andres was conducted to assess the impact of video conferencing tools on the productivity of virtual software development teams (Andres, 2002). Andres presented the social presence (Short, et. al 1976), media-richness

(Daft and Langel, 1986), time, interactions, and performance (TIP) (McGrath, 1990) theories. The theories Andres (2002) presents are as follows:

- **Social presence** – the ability of a communication medium to allow a group member to feel the presence of the other group members and the feeling that the group is jointly involved in communicative interaction (Short et al., 1976)
- **Media richness** – a continuum on which a communication medium is assessed based on the "richness" of information it transmits (i.e. "lean" – email, "rich" – video conferencing).
- **Time, Interactions, Performance (TIP)** – work group members participate in three primary categories of activity: production (identify project goals, determine work tasks, etc.), group well-being (acquisition of role clarity, conflict resolution, etc.), and member support (show support of other team members' contributions, conflict resolution through negotiation, etc).

He coupled these theories with software development literature to build a framework to assess the impact of face-to-face and video conferencing on software project success. The researchers hypothesized the following:

- H1 – Groups working in face-to-face teams would experience greater team productivity than teams using video conferencing equipment.
- H2 – Groups working in face-to-face teams would experience greater perceived interaction quality than teams using video conferencing equipment.
- H3 – Groups working in face-to-face teams would experience greater group process satisfaction than teams using video conferencing equipment.

The researchers conducted the study by putting together several design teams charged with improving a hypothetical university information system. The four-person design teams consisted of undergraduate students knowledgeable in both Systems Development Lifecycle processes and the C++ programming language. The teams were required to develop design documentation that included hierarchy charts, function prototypes, and pseudo code. The teams were split into dyads that had to communicate face-to-face and through video conferencing technology. In order to accurately gauge the richness of these two communication approaches, Andres did not allow the participants to share physical documentation across the dyads. Also, each dyad had to convey requirements that were intentionally withheld from the other dyad. The two classes of measures for this study were task outcome and psychosocial outcomes. The task outcomes were measures of productivity, which was measured by the level of completeness of the design documentation (file design, specification of function prototypes, and pseudo code). The psychosocial measures were interaction quality and process satisfaction. These measures were captured within a survey. Figure 2 shows the questionnaire items:

Interaction quality

When working on this project, to what extent did you:

- Feel frustrated or tense about the other team members' behavior;
- Express negative opinions about any project team member's behavior;
- Observe others express a negative opinion about your behavior.

The *genuine participation* items were rated on a five-point (1-5) Likert scale.

Group process satisfaction

How would you describe your team's software development process?

- Fair … unfair;
- Confusing … understandable;
- Satisfying … unsatisfying.

The *software development (or group) process satisfaction* items were rated on a five-step semantic differential scale with the anchors shown above.

Figure 2 - Face to Face vs. Virtual Team Questionnaire (Andres, 2002)

Results

Table 4 - Face-to-Face vs. Virtual Team Results

	Team productivity		**Interaction quality**		**Process satisfaction**	
Communication medium	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Video conferencing	8.67	5.44	10.88	2.51	10.42	2.73
Face-to Face	15.50	3.28	12.83	2.06	11.50	1.93

Table 5 - Face-to-Face vs. Video Conference Hypothesis Results

Hypothesis	**Result**
H1: Groups working in face-to-face teams would experience greater team productivity than teams using video conferencing equipment	Supported by results
H2: Groups working in face-to-face teams would experience greater perceived interaction quality than teams using video conferencing equipment	Supported by results
H3: Groups working in face-to-face teams would experience greater group process satisfaction than teams using video conferencing equipment.	Not supported by results

Discussion

The gap in productivity is substantial between the face-to-face and virtual teams in this study. However, Andres only allowed verbal communication as the means for the dyads to share data with each other. A blend of communication mediums would surely close the gap in performance between the teams. Andres does allude to this when he mentions that "The superior productivity experienced by the face-to-face groups suggest

that multiple channels of communication (i.e. 'rich media') are needed to facilitate better information acquisition, sharing, and integration." There have been numerous innovations in collaboration tools since this study was conducted in 2002. "Rich" media is highly available. Tools such as Instant Messaging, Team Portals (i.e. SharePoint), Desktop Sharing (i.e. Web-Ex, GoTo Meeting), and Video Conferencing (Skype) are widely available and supported by corporations today.

3 - BOEING-ROCKETDYNE – CASE STUDY

From 1958 through the 1980s, Boeing-Rocketdyne (then Rocketdyne) was the dominant player in liquid-fuel rocket engines. However, after the breakup of the Soviet Union, Russian rocket engine manufacturers challenged their business by producing much cheaper engines. Boeing-Rocketdyne's response came through a program manager named Bob Carman. He envisioned a better designed rocket engine that was much cheaper to manufacture. Boeing-Rocketdyne created a team called SLICE (Single Low-cost Innovative Concepts Engine) charged with significantly driving rocket engine costs down, increasing speed to market, and increasing the useful life of a rocket engine (Malhotra, Majchrzak, Carman, Lott, 2001-add to ref.). However, Boeing-Rocketdyne did not employ all of the resources required for this effort. The eight-person team was comprised of members from three companies at three different locations (Boeing-Rocketdyne: Canoga Park, CA; Raytheon (then MacNeal-Schwendler Corp. Software): Santa Ana, California; and Texas Instruments: Dallas, TX). This team included a project leader, concept designer, lead engineer, combustion analyst, thermal analyst, manufacturability engineer, CAD specialist, and a stress analyst. In addition to the challenges of physical separation, the team had members (including the team lead) who

did not have rocket design experience (Malhotra et al., 2001). Additionally, the team had not worked together in the past and would have to establish relationships and team norms to move forward.

Besides the kick-off meeting (which all members did not attend), there would be no face-to-face meetings during the project duration. The team used a combination of telephone conferences and custom developed electronic collaboration tools to work on the design. Over the ten month duration, the team conducted 89 virtual meetings and logged 651 entries into the collaboration tools including an Internet Notebook and a Project Vault. The Internet Notebook was used for the collaboration (which included a shared whiteboard space) and the Project Vault was used to store documents that were not expected to change.

Results

The resulting effort was a reusable rocket engine that was developed in only ten months (one-tenth the time span it took to develop its predecessor—and 1% of the actual number of hours). The newly designed thrust chamber was made of six parts vs. the approximate 1200 parts of the predecessor design. As a result, the manufacturing costs were substantially less. The predecessor rocket's manufacturing cost was $7 million, and the new design's cost is $.5 million. The quality of the design was estimated at a 9 sigma vs. the more conventional 2 to 4 sigma for rocket engine combustion devices (Malhotra et. al, 2001). Additionally, the standard first unit production cost of $4.5 million was reduced to $47,000 (Malhotra et al, 2001). During the effort, the project team had only one face-to-face meeting (which included five members) and the team as a whole spent about 15% of each work week working on the project (Majchrzak, Malhotra,Stamps, Lipnack, 2004).

Discussion

This is a real world example (vs. student research study) that shows the potential of virtual teams. It suggests that virtual teams can be as productive as and possibly more so than co-located teams. In fact, members of the project team agreed that they would not have been able to accomplish the task as well had they been co-located together. One of the SLICE team members mentioned that the virtual meetings made them articulate their thoughts better than they would have in a face-to-face meeting where they could depend on visual cues (Majchrzak et. al, 2004).

People

Although the discussion of personality types was not heavily discussed in the papers that were surveyed on this particular study, it was noted the people on the team were very highly motivated and entrepreneurial in spirit (Gene, 2002). It should also be noted that the people on the team resided in the continental United States. As such, they probably did not experience the same level of challenges global teams face when working together (cultural, communication barriers, etc.). The leadership position of the lead engineer was also minimized as a result of the highly available data to all team members.

Processes

Meetings were set up as working meetings where team members would multi-task with their parent companies and come back to teleconferences as needed. Also, team members would perform analysis on their computers during calls to give instant feedback on a design suggestion or idea. This is different than a face-to-face meeting where people are normally gathered in a conference room.

Technology

The collaboration tool was critical for knowledge sharing across the distributed team. However, it is important to note that the collaboration tool was modified over 23 times during the course of the project (Malhotra et. al, 2001). This is an advantage that other teams may not have had at the time this project was run (1997). This team had the technology developed to their exacting specifications. However, as of this writing, modern day collaboration tools such as Web-Ex, Goto Meeting, Skype, etc. have much of this same functionality built in.

4 - SIEBDRAT, HOEGL, AND ERNST STUDY

Research by Frank Siebdrat, Martin Hoegl, and Holger Ernst (2009) poses the following two questions:

(1) When do virtual teams outperform co-located ones?

(2) How should companies manage dispersed teams?

The answer to these questions comes from their study of 80 software development teams from 28 different labs in countries including Brazil, China, Denmark, France, Germany, India and the United States. The labs vary in size (between 20 and 5,500 software developers), and each team contains up to nine members. The research includes software development projects that were completed 12 months prior to data collection. 392 managers, team leaders and team members participated in the study. The two primary measures for the study are geographic dispersion and performance. The geographic dispersion metric is determined by accounting for the following factors: (1) Miles between team members, (2) time zone difference, (3) number of locations per team, (4) percentage of isolated team members, and (5) unevenness of membership across sites. In

order to measure performance, managers assessed both team effectiveness and team efficiency. To measure effectiveness, managers rate the teams on product quality, reliability, usability, and customer satisfaction (it should be noted that there are additional effectiveness measures that the authors of the study mention, but do not specify). To measure efficiency, managers rated teams on how well they maintained both project budget and schedule constraints.

Results

The researchers found that key drivers of performance were crucial team processes that helped coordinate work and facilitate communication among members. Figure 3 shows how both high and low levels of team processes impact team performance, and how these levels change based on the level of team dispersion.

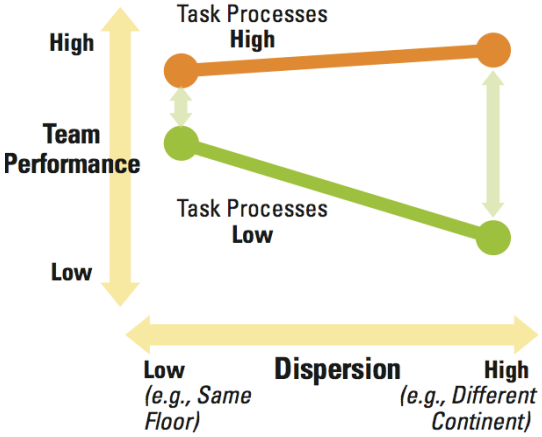

Figure 3 - The Importance of Task-Related Processes
(Siebdrat et al., 2009)

The team processes were categorized as:

(1) Task related- help ensure each member is contributing fully

2) Socio-emotional- increase the cohesion of the group. (Siebdrat et. al, 2009). Figure 4 illustrates the measured levels of effectiveness and efficiency across varying levels of dispersion.

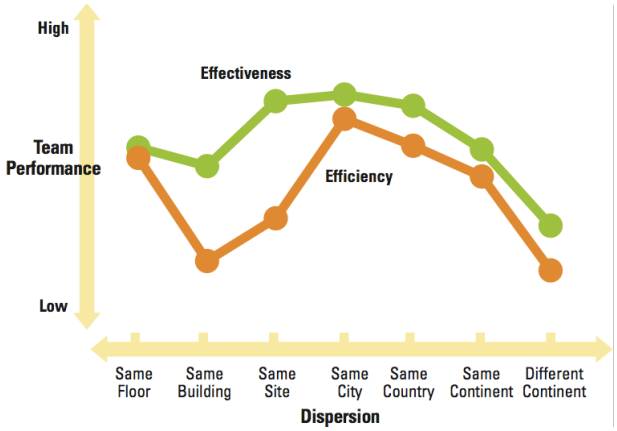

Figure 4 - Small Distances Matter
(Siebdrat et. al, 2009)

Discussion

People

The authors of the study mention that as managers make selection decisions for members of the virtual team, they need to consider social skills and self-sufficiency of the team members (Siebdrat et al., 2009). Although social skills are also critical for co-located teams, the ability to skillfully negotiate issues, to effectively communicate a position, and to carefully listen to team members is critical to a well-functioning virtual team. As the authors indicate, self-sufficiency is more important for virtual team members because in the instance of isolates (remote individuals), a team leader will be in less of a position to help team members manager their work.

Processes

The results indicate that distributed teams with well-defined task oriented processes can perform at levels equal to or greater than co-located teams. (Siebdrat et. al, 2009). It is also interesting to note that the results show that widely dispersed teams can outperform teams that are co-located, and teams that are only separated by floors! The

implication (as the authors note) is that the latter types of co-located teams do not feel as if they are dispersed and do not focus on work processes that can improve the team performance. The authors indicate the importance of socio-emotional processes, but only in the context of their positive influence on the task oriented processes. They did not have sufficient data to indicate that teams with good socio-emotional processes performed better than those without.

Technology

The authors did not mention the use of technology and the possible impact on the performance of the teams. Perhaps this is due to the nature of the work (software development), and it is understood that for this type of work to succeed, excellent collaboration tools must be (and are) available.

5 - TEAM EFFECTIVENESS IN DISTRIBUTED AND CO-LOCATED ENGINEERING TEAMS

Maria C. Yang and Yan Jin conducted a study that looked at the effectiveness of virtual teams compared to co-located teams (Yang, Yin, 2008). The primary goal of this study was to look at social and task related dimensions of the two team types, and to improve performance of these teams in both the academic world and the work force. Two groups of engineering students from different classes at University of Southern California were utilized for the study.

The first group ("distributed") of students was part of a Master's program and had 33 students. 11 of the students full time working engineers and were distributed across the United States. The distributed students were divided into 8 project teams. Each of the teams consisted of 3 to 5 members, and at least one of the students was required to be distributed. Also, 6 of these teams had at least one member who was "near" enough to

meet with the team at least once during the project. The remaining 2 teams had distributed members that were too "far" away to meet with the team in person during the project. Their assignment was to analyze and study a real-world team and provide recommendations on how that team could improve their performance.

The second group ("co-located") of students was senior aerospace and mechanical engineering students. All 33 students were full-time on-campus, and had limited work experience relative to the other team. There were 8 project teams with 3 to 6 members. Their assignment was to solve a mechanical engineering problem that had poorly defined requirements.

At the completion of the project, the team members filled out a 2-page questionnaire. The questionnaire, which covered both social and task dimensions, asked the students to rate their teams across 10 team effectiveness characteristics. They used a 7-point scale (1 low, 7 high) to measure effectiveness. The team effectiveness characteristics were the following:

1. Goals and objectives – The team's ability to understand and agree commonly understood goals.
2. Utilization of resources – Team member resources are recognized as well as utilized.
3. Trust and conflict – The degree of trust among team members, and ability of team to handle conflict openly.
4. Leadership – Sharing of leadership roles among team members.
5. Controls and procedures – Effective procedures for team functioning that team members support and use to regulate team function.
6. Interpersonal communication – Communication between team members is open and individuals participate.
7. Problem-solving/decision-making – Established procedures for group problem solving.
8. Experimentation/creativity – Ability to try new or different ways of doing work as a team.
9. Evaluation – The frequency with which a team examines their own functions as a team.

10. Cohesion – The level of enjoyment of working together as a team.

Results

Table 6 - Average rating for each team effectiveness characteristic by distributed teams and co-located teams (table adapted from Yang/Yin study and added last three columns)

	Avg. Distributed	Std. dev.	Avg. Co-located	Std. dev.	Compare	People	Processes	Technology
Goals & Objectives	6.1	0.83	5.85	0.89	Same		✓	
Utilization of Resources	5.58	1.09	5.53	1.26	Same		✓	
Trust & Conflict	5.16	1.27	6.06	0.92	Co-lo higher	✓		
Leadership	5.29	1.24	5.21	1.49	Same	✓		
Control & Procedures	5.19	1.19	5.18	1.38	Same		✓	
Interpersonal Communication	5.58	1.09	6.00	0.98	Same	✓	✓	✓
Problem Solving	5.19	1.35	5.35	1.3	Same		✓	✓
Experimentation	5.03	1.2	5.5	1.11	Same		✓	
Evaluation	4.39	1.43	5.32	1.39	Co-lo higher		✓	
Cohesion	5.65	1.11	6.00	1.04	Same	✓		

Discussion

This study indicates that the virtual teams' level of effectiveness were the same as co-located teams across eight of the ten dimensions measured in this study. One of the two areas where the virtual team effectiveness rated lower was "Trust & Conflict." This is consistent with existing studies and experiences of the author of this thesis. This could potentially improve if the team works together over an extended period of time. The team in this study worked together for a few months. The second category where the virtual teams rated below co-located teams was in "Evaluation." This suggests that the virtual teams did not evaluate (and improve) team performance as often as the co-located teams. Since the projects were only a few months in duration, perhaps the teams did not

focus on this as much as they would during longer engagements. Despite the differences in these two measures, it is important to note that both the virtual and co-located teams rated themselves very close in effectiveness.

CROSS CASE ANALYSIS

Although the case studies reviewed and discussed are different in overall scope and goals, there are common themes across the cases. Many of these themes are also discussed in the literature review. The following table summarizes the cases and this author's opinion on how they answer the thesis question of whether or not virtual teams can perform at or greater than co-located teams:

Table 7 - Cross Case Analysis Summary

Case	Can Virtual Teams Perform at or Greater Levels than Co-located Teams?	Key Issues/Contingency Factors
Case 1 - Global,Virtual, and Co-located NPD Te	No.	People - Level of dispersion appears to impact performance. The larger the distance between team members, the worse the performance. Processes-Project management issues were greater for the global and virtual teams. These same issues were not experienced by the co-located teams.
Case 2 - Virtual and Co-located Software Team	No.	Technology - the only technology used was video conferencing. No collaboration tools were used. However, the researchers indicate that multiple communication channels would help bridge the gap in performance.
Case 3-RocketDyne Rocket Project	Yes.	People - Team members are highly independent, driven, and entrepreneurial. Processes - Teams utilized task oriented processes focused on maximizing each member productivity, meetings, and communication rules. Technology - The teams used very effective collaboration tools (i.e. virtual whiteboard, virtual notebook).
Case 4-Virtual Software Field Study	Yes.	People - Team members and leaders are very socially aware (High Emotional IQ). Processes - Task related processes are more important than socio-emotional. The latter improves as the team realizes successes enabled by the task related processes.
Case 5-Engineering Student Virtual Study	Yes.	People - The following measures of effectiveness were important for high performing virtual teams: leadership, interpersonal communications, , and cohesion. Processes - The following processes were critical for high performing virtual teams: setting goals and objectives, utilization of resources, effective controls and procedures, facilitation of interpersonal communication, team problem solving, and facilitation of experimentation/creative problem solving.

Chapter 4: Conclusions

After reviewing the cases that were presented in Chapter 4 and the vast array of literature on the topic, it is apparent that the answer to the thesis question, "***Can virtual project teams perform at levels equal to or greater than co-located teams? If so, on what contingency factors do virtual team performance depend"*** is yes! The contingency factors are described within the following categories: People, Processes, and Technology.

PEOPLE

A certain set of Knowledge, Skills, and Abilities are required for virtual teams to be successful. The effective virtual manager will consider these KSA's when recruiting virtual team members:

(1) Highly Motivated – must be able to self-direct and not require a leader to continuously help manage work.

(2) Socially Aware or "Emotionally Intelligent." Daniel Goleman defines Emotional Intelligence as "the ability, skill, a self-perceived ability to identify, assess, and control the emotions of oneself, of others, and of groups." (Goleman, 1995). This is important for all members of the team, but is even more critical for virtual team leaders. This becomes more evident as the level of team dispersion increases.

(3) Effective communication skills – It is imperative for team members to be very competent in both written and oral communication. This is critical because most virtual team communication is either on teleconference or written electronic communication. According to Dr. Al Jury, an expert on virtual

teams, the virtual leader must focus on being very "virtually present." He recommends communicating with team members using very "media rich" communication tools such as video conferencing tools. (Jury, 2011).

PROCESSES

In order for virtual teams to perform at high levels, there must be a focus on the type of processes put in place for a team to operate. As noted in the various case studies, well-defined task related processes are critical for high performing virtual teams. This includes having processes for running effective meetings as well. As previously mentioned, it is imperative that meetings are carefully planned to maximize the use of team member time. It is also important to build in socio-emotional processes that support building team rapport and trust (Jarvenpaa, Leidner, 1999). Dr. Al Jury recommends building in time for social interaction (Jury, 2011). This could include a few minutes at the beginning of meetings to discuss non-work issues. This happens naturally within co-located teams.

Managers must put in place effective ways to manage team performance. The days of accounting for every hour of the week are gone. The new virtual team leader should focus on results vs. "bean counting" the hours spent on work tasks. Results can be measured through project plans or scorecards stored within a collaboration site. The continued feedback loop helps build both individual and team efficacy.

TECHNOLOGY

At the beginning of this paper, several "world flatteners" were listed. The most critical of these is the internet, and the ways that teams can be brought together using

tools that utilize internet technology. As previously noted, virtual teams should use the right technology at the right time. The technology should change based on the type of information sharing that is required for the meeting.

RECOMMENDATIONS

The author of this thesis is primarily interested in improving the performance of a global virtual software development team. However, the following recommendations can be used for various virtual team types. The following recommendations have and will be implemented in current and future software development initiatives within the author's company. Hopefully these recommendations are also useful to other virtual team practitioners or researchers.

Implement Virtual Team Training Programs

The effective virtual team manager will implement training programs. This is more of a critical issue for globally dispersed teams, but teams with less dispersion can benefit as well. For multi-cultural teams, this author recommends scheduling a 3-4 day face-to-face "pre-project" workshop with facilitated sessions focusing on the cultural issues. The teams work on "mini-projects" during the week to start building rapport, and establishing trust. This can develop healthy patterns that carry forward into the larger project.

Schedule Face to Face Meetings Early and as Often as Possible.

Although some of the literature recommends against this, it is from personal experience that this author highly recommends scheduling face to face meetings as

frequently as possible. Some of the literature recommends against this because fault lines can occur early due to differences in culture (appearance, language, etc.). These same researchers posit that electronic communication levels the playing field (Staples, Zhao, 2006). This might hold true if email and collaboration portals are the only communication tools used. However, with the use of voice over IP phones, phone conferences are more than likely the most utilized method of communication. This author suggests that fault lines can occur early if voice conferencing is used and the groups do not understand each other. The early face-to-face meetings can help improve communication substantially. As Jarvenpaa and Leidner indicate in their research, these early impressions and communication patterns are critical to building trust early (as well as maintaining it) (1999). During face-to-face communication, the subtle, rich visual cues, and the ability to see an individual's mouth moving, is very helpful in understanding a foreign accent.

Consider Team Size/Configuration Impact on Performance

Finally, according to the O'Leary, et. al study, the size and configuration of distributed teams has an impact on performance (O'Leary, et. al., 2006). If possible, the virtual team manager should consider balancing team sizes when recruiting for team members. If balancing is not possible, the virtual team manager needs to be aware of the "fault lines" that can occur within mixed configuration sizes and try to manage accordingly. As the study mentions, the exception to the balanced team is the case where isolates (lone workers) are present. Isolates did not experience the fault line problems experienced by the other sub-teams. The issues with these team types should be discussed in the previously mentioned training program.

As the world continues to flatten, it is important for leaders to understand how to leverage virtual resources. This is no longer an option for companies that are competing in a global environment. The cost savings and availability of global resources are major contributing factors. The latter point was illustrated by Dr. Shervani when he presented a forecast of available knowledge workers through 2020 (Shervani, 2005). The U.S. showed a significant deficit while other countries such as Eastern Europe, South/Central America, and Asia had a surplus. If the projections are accurate, the usage of globally dispersed virtual teams will continue to grow. This presents opportunities for good virtual team managers (and those that study them).

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Vita

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