ABSTRACT

Today’s knowledge economy relies on working across vast distances without having to constantly travel from location to location. Teams develop and deliver products virtually, particularly in knowledge industries like information systems (IS) development. Getting the most out of knowledge workers in these virtual settings presents formidable challenges. One key challenge is how to best use information and communication technologies to improve team interaction and project outcomes, and technology facilitation offers a lever for achieving this improvement. No prior study has addressed technology facilitation in virtual teams (VTs). This study filled this gap.

This study framed the virtual teams literature using adaptive structuration theory (AST) to create effective questions for 2-hour interviews with 13 practicing, successful virtual team leaders currently working in large IS development projects. These leaders were high-performers. Eleven of them reported being used as “fixers,” project leaders their firms called when things went wrong in a project. The 30 projects they reported contained team members from four organizations and three national cultures on average. Their median monthly budget was
$625,000, and they used more than 12 information and communication technologies (ICTs) per project, a number larger than prior literature had reported.

The study employed critical incident technique (CIT) as the methodology underlying this application of AST, finding a very strong fit between CIT’s ability to sample technology appropriation and AST's need to focus on the actors and moves of appropriation in order to establish the events in a structuring episode. CIT directs the application of interviews for examining a job role, in this case virtual team leader technology facilitation. This role had not been studied before, and few studies had even attempted to focus on actors and moves within the appropriation process in the AST literature perhaps due to the difficulty of doing so. The AST-CIT fit developed here offers a valuable guide for future research. It enables an actor-move emphasis to be examined using practicing VT leaders or members.

The 30 projects and 52 critical incidents reported by the interviewees yielded 510 pages of transcribed data. The data were content analyzed in a careful process involving multiple coders to ensure validity. Through this process these data developed into dimensionalized constructs grounded in empirical observations from the field that describe the process of technology facilitation in virtual teams.

These five constructs are: 1) structural **triggers** of technology facilitation, 2) leader **actions**, 3) structural **changes**, 4) team **outcomes** due to structural changes’ impact on work, and 5) **beliefs** within leaders’ mental models of technology facilitation.

Important findings include descriptions of these constructs and how they work, identification and definition of participation and information processing capacity as a chief
intermediating variables that link structural changes to team outcomes, a useful new hybrid
approach to studying technology appropriation using AST and CIT, understanding of how leader
knowledge of ICTs becomes critical and enables or disables successful VT work, and evidence
that training and persuasion by VT leaders must be encouraged and enabled to maximize
technology facilitation effectiveness. Nine propositions with two sub-propositions are presented
as guidance for future research along with additional suggestions for researchers, practitioners,
and ICT developers/vendors. These findings give insight into the changing nature of leadership
in virtual settings and means for achieving higher productivity from knowledge workers.

INDEX WORDS: Technology facilitation, team leadership, virtual teams, adaptive
structuration theory, critical incident technique, research methods,
distributed work, knowledge worker productivity, structuration episodes,
technology appropriation, IS development projects
THE TEAM LEADER TECHNOLOGY FACILITATION ROLE IN INFORMATION SYSTEMS PROJECT VIRTUAL TEAMS

by

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B.A. English and American Literature, Brandeis University, 1994

A dissertation submitted to the Graduate Faculty of the University of Georgia in Partial Fulfillment of the Requirements for the Degree

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THE TEAM LEADER TECHNOLOGY FACILITATION ROLE IN INFORMATION SYSTEMS PROJECT VIRTUAL TEAMS

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August 2005
DEDICATION

This dissertation is dedicated to three very special people.

Two entered my life while the dissertation proceeded and one left.

To my son, Maddock Simms Thomas.
May he be happy and healthy and live long!
May his heart be filled with love and peace.

To my wife, Katherine Anne Smith.
May she find happiness and joy in nature and simple, daily existence!

To my mother, Freida Miller Thomas.
There is no way to comprehend the many ways her powers and devotion have enabled my life. Thank you.
ACKNOWLEDGEMENTS

I hope it is clear to all who read this that the human endeavor is almost always characterized by team efforts. We are by nature social beings, and the success at building and supporting teams is critical to success in many of the things we do not only in business but also in education, health care, and family life. Many people have been part of my team in completing this dissertation, and I would like to take this opportunity to recognize their outstanding efforts. The people are the most important part of a team.

First of all, I suppose every dissertation requires a lot of time and energy. This one certainly did. Many people helped and supported me in this process. The most fantastic supervisor one could desire, Bob Bostrom, certainly served double and triple duties. Who else would turn around 300 pages of draft in one day? Who else would take me out sailing when my soul was suffering? I was lucky to have a chance to work under Bob. Without his keen and kind guidance and friendly but solid standards, I would have had much more trouble completing this work.

Bob’s efforts complemented the efforts of my committee. I selected them due to my respect for them as mentors and researchers and my understanding that they would demand a quality product and support its creation. I was not disappointed. Thank you to Rick Watson for demanding theoretical import and leading me down productive pathways. Thank you to Dale Goodhue for overseeing my methodological development while also providing feedback and suggestions on a wide variety of topics. Thank you to Dave Chatterjee for his support in
understanding and dealing with the practitioner community and his insight and guidance on making the findings relevant to virtual team leaders.

Melenie Lankau served as the fifth and outside member of my committee. Melenie also served as my supervisor for three years as we created the Leonard Leadership Scholars program within the Institute for Leadership Advancement at the Terry College of Business. I enjoyed the time we spent working together. During this study, she provided detailed, succinct, practical feedback on the entire dissertation draft. She also opened doorways into areas of theory in the management literature that turned out to be very fruitful.

Perhaps not every dissertation requires a cadre of Ph.D. students to support it, but this one did! My officemate, Saurabh Gupta, who is also lucky to have Bob as his advisor, helped with coding and refinement of concepts and constructs, as well as editing and moral support. Chris Kadlec, the other long-time Ph.D. student in the department and also lucky to have Bob as his advisor, provided many hours of coding, humor, and moral support. Others also provided coding, moral support, and/or feedback aid, including Chon Abraham, David Preston, Daniel Chen, Iris Junglas, Thilini Ariyachandra, Ashley Davis, Justin Cochrin, Clay Williams, Hui Wang, Greta Polites, Greg Dawson, Martina Greiner, and Donald Wynn. Paul York and Chris Kadlec also helped with some technical assistance. Greta Polites, Greg Dawson, and Clay Williams also provided very useful insight into the current state of IS development projects in virtual teams.

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and she added insight from her expertise in the field of information science and specialization in the impact of medium on personal information systems such as journals. Thank you to her.

My father, a retired scholar of sociology and social welfare on whose committee John C. Flanagan [founder of critical incident technique] ultimately sat at his defense, put in many hours. His work included moral support, methodological guidance, insight into the process of getting the Ph.D., and coding and sorting among other things. He would not want to be listed here, but I list him anyway. Thank you to Dad.

My wife Katherine Smith gave me a beautiful son. Thank you to her and to my son.

To the many other helpers and supporters. Thank you. Among them I would like to recognize a few: Gigi Kelly, Vicki Clawson, Marianne Gouge, Elena Karahanna, Marie-Claude Boudreau and Larry Seligman. Sometimes the short conversations and encouragement led to overcoming blocks that might otherwise have stalled me for weeks or months. This kind of support should not be underestimated. In addition, Larry, Marie-Claude, and Elena each organized the MIS seminar for a period during this dissertation, and I took advantage of that forum to present my ideas and receive valuable feedback and practice on three occasions. I am glad I had that opportunity. I also appreciate the audience members at several conferences and presentations who provided input.

To the thirteen virtual team leaders who must remain anonymous here, thank you. You made this study possible.

One special, last human thanks goes to Lynn Markus. I appreciate the conversation we had about participation and its implications and needs in current IS research.
These acknowledgements would not be complete if I did not also recognize the various information and communication technologies (ICTs) that made this dissertation virtual team workable. Though one cannot list them all because some are so pervasive as to be entirely taken for granted, for instance, I leave out my watch, I used the following at various points (listed in best-guess order of frequency of use, which does not indicate importance necessarily). I thank their developers and vendors for their support:

1. Computers (running Apple OS X or Windows or Redhat Linux)
2. Email (particularly Apple’s Mail which has excellent organizational and search features in the current OS [Tiger])
3. Microsoft Word (particularly word processing and Track Changes feature)
4. EndNote
5. Phone
6. Paper, pencil, post-its, and three colors of pens
7. Apple iPod with Recording Adapters (used to record all interviews and backup all documents)
8. Apple iTunes with scripting (used to create transcription capability in Word)
9. Microsoft PowerPoint (especially for drawing figures)
10. Face-to-face (primarily meetings with Bob, some were by phone or email)
11. Web page on dominict.net (central, asynchronous resource for information)
12. HTTP document server on dominict.net (central, asynchronous document download access)
13. Web-based survey tool on dominict.net (central, asynchronous leader background data collection and unique identifier generator)

14. Abode Acrobat (assembling and securing sensitive PDF files for electronic transfer)

15. Fax (signed forms to and from participants)

16. Groove workspaces (for personal file replication at multiple locations and for replication of coding documents for coders to work virtually and simultaneously in distributed locations)

17. Atlas.ti coding software

18. Instant messaging (Groove, MSN, and AOL: with Bob, coders, and participants)

19. Microsoft Access

20. Microsoft Excel

21. USB RAM disk

22. BBedit and Macromedia Dreamweaver (Web page design and editing)

23. Postal Mail (signed forms to and from participants)

24. Skype telephony (one interview conducted through Skype)

25. Cell phone (one interview conducted by cell phone)

If anything, I hope this list provides a nice introduction for you into this dissertation and how the world of ICTs facing virtual teams is not simple and deserves study in all of its complexity in real teams!
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CHAPTER 1: INTRODUCTION

1.1 Virtual Teams in Organizations

The modern, global economy relies on information technologies for improvements in the many processes that enable trade. One of those key processes is project work conducted in teams. The virtual team (VT) exists in this expanding project workspace created by economic need and new information and communication technology (ICT). The explosion of VT use in industry has been phenomenal in the past several years. Reports indicate that more than half of all companies with over 5000 employees are using VTs and more than 60% of white collar workers participate in VTs (Martins et al. 2004). With the increasing popularity of VTs, particularly in highly complex information systems projects, have come reports of team project failure and a need for improved effectiveness (Chandrasekaran et al. 2004; Hayes 2004; Kaiser et al. 2004; Tiwana et al. 2003; Xia et al. 2004).

VT technology facilitation by leaders offers a potentially powerful lever for improvement of a team’s technology usage and, thereby, a lever for improving VT project success. In the preceding sections, we hypothesized that VT leader technology facilitation exists and that it is important. Some direct evidence shows that the VT leader technology facilitation role does exist, is important, and the need for it occurs frequently. We present two brief cases from interviews with VT leaders to help illustrate this point.
1) A leader was running a large systems analysis and design project for a government client and a telecom company. His team was spread from the United States to the United Kingdom. The team developed project requirements and presented them to the clients in printed form, but the clients balked, jeopardizing a multi-million dollar contract. The leader needed to immediately win the clients’ trust and ascertain if his team’s analysis was correct. Within five hours of the clients’ hesitation, the leader had changed team roles to enable members to directly communicate with the clients. He had also setup a non-recrimination policy for the meeting, a policy ensuring no one would be punished for discovering an error so that members could focus on project effectiveness and accuracy. Finally, he opened up the team’s internal systems to the client in a large virtual meeting, expanding the use of their internal ICTs into the client’s realm. The meeting was highly successful and the project was saved because, according to the leader, the team was able to use their ICT to work openly and effectively with each other and their clients. If the leader had not facilitated ICT use in conjunction with a non-recrimination policy and team role redesign, the project would have failed.

2) A multi-year, multi-million dollar data warehouse software redesign project had been progressing poorly. Team members in France were not getting along with U.S. ones. The team leader realized that something needed to be done, because deadlines were being missed and members were complaining. A large number of ICTs were being used, including email, file servers, application sharing, audio conferencing, calendaring, content versioning tools, a groupware suite, project management software, and the telephone. The leader determined that emails were being misunderstood and directed the team members to use audio conferencing or direct telephone calls instead. Other than this mandate, no additional steps were taken. For a period of three months after this, there was some improvement in relations, although the leader
noted that she had to re-mandate and prompt members to use the phone instead of email. Relations worsened, and the project began to dissolve, because, according to the leader, the team members were not able to communicate effectively with the technologies they were using. When the leader left the project, senior management decided to terminate the U.S. members’ involvement.

Technology facilitation is a lever for team performance improvement. In the first case, it was done well and helped save the project. In the second, it was done poorly and contributed to the project’s failure. Much can be learned from studying such cases. Virtual team leaders offer critical and under-studied insights into improving virtual team effectiveness (Gibson et al. 2003; Zigurs 2003), especially as they relate to technology in teamwork processes (Bell et al. 2002). This dissertation explored virtual team leader effectiveness at improving teamwork through technology facilitation. The dearth of empirical research on this topic allowed this study to fill a much-needed gap and provide valuable information for modern, global business teams and for information systems researchers.

1.2 “Virtual Teams” Defined

The term “virtual team” can be defined many ways (Martins et al. 2004). In discussing virtual teams, some studies’ definitions emphasize a single aspect that differentiates them from traditional, single-site work teams of the past, as in “distributed teams”; others emphasize multiple aspects such as wide geographic dispersion, temporal separation, and cultural diversity, as in “global virtual teams”. To avoid confusion, we define virtual teams (VTs) along the lines of earlier work (Townsend et al. 1998) and add a few refinements from current research. Virtual teams are groups of people who operate as a social unit and have one or more interdependent tasks. They communicate predominantly through information and communication technologies.
This definition places virtuality on a spectrum from completely electronic or computer-mediated with no face-to-face (FtF) interaction to completely FtF and non-computer-mediated. Under this definition, as virtuality increases, VTs face a whole new environment in terms of information acquisition, storage, interpretation, and dissemination, leading to increased difficulties and distinct challenges relative to traditional FtF teams (Avolio et al. 2003; Cramton et al. 2003; Malhotra et al. 2004).

1.3 Virtual Team Research Gap

Virtual team usage in industry is relatively new and raises many unanswered questions. Research on VTs is still in a very early stage in terms of addressing the many questions that surface in the business world (Martins et al. 2004; Powell et al. 2004). Virtual group and team research has examined a range of issues including effectiveness relative to social-psychological inputs (Furst et al. 1999), critical success factors in cross-organizational ad hoc virtual teams (Lipnack et al. 1999), project management and success (Paré et al. 1999), knowledge transfer (Griffith et al. 2003), teams dynamics, communication, and outcomes (Maznevski et al. 2000), ICT choices and preferences, specifically media stickiness (Huysman et al. 2003), group relations and trust (Jarvenpaa et al. 1999; Piccoli et al. 2003), learning in cross-functional virtual teams (Robey et al. 2000), socialization in virtual groups (Ahuja et al. 2003), and leadership effectiveness (Kayworth et al. 2002).

Overall, the focus of VT research has been on social issues rather than use of technology support (Malhotra et al. 2004) or team process (Fiore 2003), even though VTs face a critical daily problem of planning their use of information and communication technology (ICT) (Sarker et al. 2004; Suchan et al. 2001). This problem of figuring out how to use the ICT applies directly
to recent research on shared mental models in team process and performance in the management
and psychology literature. Shared mental models are critical for effective teamwork when a task
is complex (Cannon-Bowers et al. 1993; Klimoski et al. 1994). Multiple models are necessary
for successful interaction (Klimoski et al. 1994). The first model a team must have is that of its
technology or equipment; “the dynamics and control of the technology and how it interacts with
the input of other team members is particularly crucial for team functioning” (p. 274, Mathieu et
al. 2000). ICT is a primary “technology or equipment” in VTs. Other critical shared mental
models are the job/task, the team interaction, and the team members (Mathieu et al. 2000).
These models rely on communication to develop and be maintained. In the case of a VT,
communication must go through the ICT. Difficulties related to ICT usage might critically
handicap a team and cause project failure.

While team research points to the need for actively managing a team’s ICT usage, VT
leader studies largely ignore this need despite the fact that leaders are likely to be in an ideal
position to expedite this role. Team monitoring and control mechanisms offer a means for
project managers to influence teams when difficulties arise, but few seem directly applicable to
the VT setting (Piccoli et al. 2003). The VT leader role in monitoring and controlling seems
likely to be different from that of a traditional team leader, more focused on facilitating,
empowering team members to take action on their own (Avolio et al. 2000; Piccoli et al. 2003).
VT leaders are often domain experts, and their lack of leadership skills can inhibit successful VT
interaction (Dubé et al. 2003a), a problem long-recognized as a contributor to team project
failure (Culbertson et al. 1980).

These observations raise some questions about VT leaders’ abilities to facilitate
technology usage. There is some evidence that VT leaders can influence information and
communication technology (ICT) use toward success or failure (Beise et al. 2004; Kayworth et al. 2002), but there is little that explains exactly what VT leaders need to know. Current VT research has neither adequately addressed the role of the VT leader in general (Martins et al. 2004; Powell et al. 2004), nor has it focused on the critical role of technology use during projects (Dubé et al. 2003a; Montoya-Weiss et al. 2001) or how leaders can manipulate a team’s use of ICT to influence team performance (Kayworth et al. 2002; Malhotra et al. 2004; Zigurs 2003).

Facilitating ICT use makes sense as an integral component of the VT leader role (Avolio et al. 2000), and part of VT leader effectiveness in this role will relate to planning how and when to use ICT as the project progresses (Beise et al. 2004; Niederman et al. 1996). Given that VT tasks are often very complex (Bell et al. 2002) and VTs must fit their communication patterns to their task (Maznevski et al. 2000), it is likely that the intricacies of VT tasks will demand ongoing adjustments to ICT to enable communication. The technology facilitation role offers a lever to improve communication through improved ICT use. Since maintaining effective team communication is a chief responsibility of VT leadership (Zaccaro et al. 2003), adjusting and facilitating the team’s ICT usage by filling the role of technology facilitator when necessary is critical.

Within the small amount of existing research on what makes a VT leader effective as a team ICT facilitator some contradictory evidence exists. For example, does a VT leader need ICT knowledge? How much technical ICT knowledge does the VT leader need? Some research on leader emergence in VTs implies that the more technical ICT knowledge the leader has the more effective he or she will be, since this knowledge would enable better communicative capabilities in the various ICTs used by the team (Tyran et al. 2003). Other research implies that too much technical ICT knowledge can be detrimental, since technical ability showed a
significant negative correlation with leader emergence (Sarker et al. 2002). The authors go on to suggest an explanation of this negative correlation, that the energy required to achieve high technical ability may come at a cost of nurturing the ability to deal with people. Taken together, these findings suggest a need for closer examination.

Prior research on technology-supported group work shows a clear need for further study of the phenomenon in field settings to avoid serious potential misunderstandings (Fjermestad et al. 1999; Fjermestad et al. 2001). Although there are some studies of VT leadership, up to now, most have been based on experiments with students, limiting their applicability to real VTs. Recently, two studies have looked directly at VT leaders and technology in the field. One examined actual managers’ perceptions of technologies (Beise et al. 2004). The other asked leaders how their teams used technology to get at knowledge sharing (Malhotra et al. 2004). No studies have focused on technology facilitation using actual leaders. This study addressed this need.

1.4 Research Questions and Deliverables

This study explored how technology facilitation happens, what contextual factors influence its success, and how it can impact project outcomes in current IS development VTs. This tri-part focus translated into three research questions. The first question and its constituent sub-questions focused on the role of the VT leader as a technology facilitator. The second question focused on what structures of virtual teamwork influence technology facilitation. The third question examined the impact of technology facilitation on team structures and team performance.
Table 1: Research Questions

1) How do VT leaders facilitate technology use?
   a) What actions do VT leaders take to structure team technology use?
   b) What mental models do VT leaders use to facilitate technology use?

2) What structural triggers lead to VT leader technology facilitation?

3) What impact can technology facilitation have?
   a) What impact does it have on structures?
   b) What impact does it have on team outcomes?

The answers to the first question helped identify how VT leaders can successfully make changes in ICT use to improve project performance. Answers to the second question described under what circumstances, relative to other VT leader roles, technology facilitation becomes crucial. The third question’s answers were useful in defining the scope of technology facilitation in improving VT performance. These answers are presented in the form of categorizations or dimensions of the five basic elements of technology facilitation: triggers, actions, structural changes, outcomes, and mental model beliefs (Table 2).
This study sought to identify the important structural relationships wherever possible. This was done by mapping categorized structures where they existed in critical incidents or in leader beliefs and then looking for significant patterns. An *ad hoc* analysis was done to identify key relationships. This final deliverable provided a foundation for developing a theory of VT technology facilitation and suggested future research directions. An *ad hoc* analysis was used, because of the difficulties in mapping and identifying patterns of non-role, process interactions in critical incidents technique data.
1.5 Importance of this Research

1.5.1 For Researchers

For academics in information systems (IS) and related fields, this research yielded four primary benefits. First, it defines behaviorally-grounded dimensions of five constructs important to virtual team technology facilitation: 1) VT leader technology facilitation triggers, 2) beliefs, 3) actions, 4) structural changes, and 5) team outcomes. These dimensionalized constructs form a foundation for understanding technology facilitation. To build upon these findings, future studies could craft surveys to explore the relationships between the constructs, leading to a theory of technology facilitation in VTs.

Second, it extends our understanding of adaptive structuration theory (AST). It does this by describing a “structuring” episode, a type of structuration episode marked by intentional structural manipulation by the VT leader. This fundamental unit in which structuration actually occurs has received very little attention in the body of structuration literature. It also extends AST by providing a test of recent advice for successful application of structuration theory to avoid tautology (Poole et al. 2004).

Third, it provides an example of Critical Incidents Technique (CIT) research, a powerful methodology rarely used in IS research that solves the important problem of how to collect accurate role- and event-focused data efficiently from practitioners. In light of AST’s actor emphasis and appropriation during structuration episodes, CIT provides an excellent fit that may be used in additional studies.

Fourth, this study suggests important relationships that can be investigated in future research. These relationships include fits between VT technology, people, and task structures that can improve performance.
1.5.2 For Practitioners

For practitioners using virtual teams in the IS development industry, virtual teams and effective use of ICTs are a hot topic (Davenport 2005). They are a primary means for outsourcing or “co-sourcing” work (Kaiser et al. 2004). They promise to increase in usage in the future in this industry (Kaiser et al. 2004) and across many other industries as well (Kirkman et al. 2002), and they present many challenges, especially for leadership and technology use.

This research produced categorizations several basic constructs important to technology facilitation. These are the VT leader technology facilitation actions, VT leader beliefs about technology facilitation, team outcomes from technology facilitation, triggers of technology facilitation, and structural outcomes from technology facilitation. Scales can be developed to measure the dimensions of these constructs. This would enable behavior-based, anchored assessments of virtual team leader technology facilitation. With such assessments, practitioners could accurately evaluate current leaders’ capabilities at technology facilitation and the factors in their environment that would influence their technology facilitation. These assessments could also be used to benchmark team performance.

Taken as a whole, this research exposes the process of effective VT leadership, based on the collected experiences of successful practicing VT leaders. It gives insight into how VT leaders can structure successful teams, projects, and ICTs. These insights form the recommendations put forth in Chapter 5. They have implications for practitioners desiring to improve training and VT design, identify missing or unnecessary information and communication technology (ICT) tools, and decide how organizational policy could better support VT performance.
1.6 Research Approach

1.6.1 Overview

We positioned this study to address the current situation in three ways: 1) the study took a theory-driven exploratory approach. It employed a theory-based model of the current, limited knowledge of VTs. This approach enabled explicit consideration of relevant theory and findings from previous research, essential information for developing the design, guiding the analysis, and integrating the findings within existing understandings (Yin 2003). This helped to enable a richer data collection by ensuring that the interview questions cover important known issues as well as help to make application of the study’s findings easier by tying the research into the existing nomological network or research in this area; (2) the sample targeted successful, practicing VT leaders in IS development projects to ensure proper contextual adequacy to observe technology facilitation; (3) the data collection technique, Critical Incidents Technique, captured qualitative and simple quantitative data on the units of analysis of interest and enabled sufficient data to be collected in a timely manner from a relatively small number of in-depth, semi-structured interviews with the VT leaders.

1.6.2 Overview of the Research Framework

Adaptive structuration theory (AST) provides the theory-base for this study (Figure 1). AST describes the process of appropriation, which is how groups of people come to use ICTs in their work (Poole et al. 2004). This process begins with an initial state in which different structures, triggering events, and personal attributes of a leader feed the appropriation process. The structures include people, technology, and tasks. The people structures are considered both individual and collective in this study, including team rules and roles as well as individual
knowledge, skills, and abilities. The technology structures are the ICTs available to the team, and the task structures are things like procedures and methods for completing the project.

![Figure 1: Adaptive Structuration Theory-Driven Framework](image)

After the initial state, appropriation begins as team members use the ICTs. The appropriation process alternates between periods of settled ICT use and periods of change, known as structuring episodes. During these episodes, VT leaders may act or intervene in team interaction to influence appropriation. Once the structuring episode concludes, new structures result. These could include changes to existing ICTs, use of new ICTs, reassignment of member roles, changes in task, or many other possibilities. Finally, the team’s productivity and ultimate project outcomes may be impacted.

1.6.3 Overview of the Research Methodology

Critical incident technique (CIT) serves as the data collection and analysis methodology in this study. CIT is a research methodology that can focus on specific, critical incidents of
behavior by a working person in a job role (Flanagan 1954). It has been used in more than 1,000 studies, including some in the leadership, marketing, and management information systems fields (Fivars et al. 2001). In this study, CIT yields a description of VT leaders’ technology facilitation role through data collected about critical incidents when the leaders facilitated technology use in their teams. Gathering the technology facilitation critical incidents data became a means for targeted sampling of structuration episodes, the appropriation events within AST. It also provided a simultaneous focus on the current state of the VT leader technology facilitation role through interviews with successful project leaders actively engaged in VT leadership.

The application of CIT in this study resulted in carefully designed, piloted, and structured, two-hour interviews. These interviews specifically targeted the 13 leaders’ sub-role as technology facilitators. The interview process included an information packet mailed in advance to each interviewee that helped them understand the focus of the interview and collected additional information via forms. Following a face-to-face or telephone interview, interviewees received a transcribed copy of their interview to review to ensure accuracy and adequate anonymity. The data were then content analyzed following a three-stage coding and sorting process that included checks to ensure validity and reliability. The resulting data provided the deliverables that answer the research questions.

1.7 Summary

This chapter addressed the importance of the research topic and the three basic research questions being explored. The adaptive structuration theory-based framework was introduced discussed in relation to its value in this study. The research methodology- critical incidents technique methodology- and how it was applied was introduced. It was pointed out that very little research has been conducted on the role of the virtual team leader as a technology facilitator
in either field or laboratory settings. This study is the first to explore this role explicitly. The study developed dimensionalized constructs grounded in empirical evidence and tied to relevant theory.

1.8 Organization of this Dissertation

The critical incidents study of technology facilitation by virtual team leaders of IS projects presented here contains the remaining chapters:

Chapter 2: Research Framework and Literature Review. This chapter guides the reader through relevant existing research literature as it relates to the application of adaptive structuration theory in this study. A conceptual model is developed and presented in order to provide the basis for targeted questions during data collection and contextually-grounded interpretation during analysis. This chapter also points out specific gaps in existing research showing how this study builds upon and extends existing knowledge.

Chapter 3: Research Methodology. This chapter describes the research design and process. The purpose of this chapter is to reproduce the methods involved in this study to enable future researchers to judge the validity of the study and to be able to replicate all or some of the study if desired. This chapter pays particular attention to the application of Critical Incident Technique in this study, how the coding and content analysis proceeded and how validity and reliability were addressed. Two pilot studies’ findings used to develop the research process and instruments are also presented.

Chapter 4: Data Analysis. This chapter presents the data collected in the study. Sections focus on the 13 leaders interviewed, the nature of the 30 projects found, description of the 52 incidents collected, categorizations and discussion for each of the five root elements of a technology facilitation critical incident- triggers, actions, changes, outcomes, and beliefs-, and an
ad hoc analysis of relationships between the structures studied. The purpose of this chapter is to present the data collected along with descriptive information for its analysis. The descriptive information includes frequency counts and summary statistics including a weight statistic developed during the study to help judge the relative prevalence of various themes within the dimensions of the individual root elements.

Chapter 5: Conclusions and Implications. This chapter presents findings and their implications based on the data analyzed in Chapter 4. The resulting discussion offers significant conclusions. We include implications for researchers, virtual team practitioners, and information and communication technology developers, as well as a section on limitations of this study.
2.0 Chapter Overview

Conceptually, many factors influence VT leader technology facilitation. These factors are only loosely defined in existing literature due to the novelty of virtual teams and consequent lack of empirical research on their leadership. Previous studies of groups interacting through technology have been criticized for failing to observe actual effects because of superficial, experimental designs (Fjermestad et al. 1999; McGrath 1993). Meanwhile, computer-mediated group work research poses many difficulties for field studies in terms of accessing the appropriate data and collecting it in a timely manner (Fjermestad et al. 2001). These challenges and criticisms of prior similar research drove our development of a conceptual framework based on adaptive structuration theory (AST) so that we could be certain to cover all relevant aspects of technology facilitation in this study using field data. AST describes the role of ICT in group interaction, how it influences interaction and how groups come to use and derive benefit from ICT (DeSanctis et al. 1994b). AST has been applied widely and successfully in research on the impact of technology in computer-mediated group interaction over the past ten years (Poole et al. 2004).

This study’s literature review is embedded within this chapter’s development of and discussion of the research framework that guided this study. Researchers attribute at least two main uses to research frameworks in empirical studies. First, research frameworks and literature reviews identify the gaps in current research.
Second, research frameworks set out a coordinative network for connecting a body of otherwise disjointed research on a topic (Tan et al. 2004). In this study, the gaps were very large (Martins et al. 2004; Powell et al. 2004). As a result, we focused our framework on the second use. We set out to identify the islands of knowledge in the sea of unknown. The conceptual framework represents the collection of these “islands of the known.” By knowing what aspects of virtual team leadership are known, we were able to target the questions asked to virtual team leaders about technology facilitation. The conceptual framework also served to inform our data analysis and interpretation in the latter stages of the study.

The conceptual framework is intentionally broad. Its breadth provided a wider view that encompassed all of the known and possibly important factors of technology facilitation for a thorough exploration and understanding of the findings. Consequently, the conceptual framework could not be interpreted as a fully identified, theoretical model of VT leader technology facilitation. Rather, it served as a skeleton to guide question development and data interpretation, a research framework. This had two general implications for question development: (1) questions needed to address the known aspects of the conceptual framework, and (2) there had to be some open, probing questions that allowed for answers to emerge that may point to any missing pieces of the framework.

The remaining sections of this chapter discuss why we chose AST and the seven relevant aspects of AST and how they were addressed in the conceptual framework. The conceptual framework is presented in a graphical form (Figure 2). The chapter ends with a chart summarizing the literature reviewed.
2.1 Why use Adaptive Structuration Theory for this Study?

The basis for this study’s research framework is adaptive structuration theory (AST). It has been widely and successfully used to study the intersection of technology and organizations (Poole et al. 2004) including VTs (Powell et al. 2004). It has been suggested and used for the study of leadership in virtual settings (Avolio et al. 2000) and the study of dynamic effects of ICT in groups (Reinig et al. 2002). Though researchers have recommended AST for a study such as this, there are some controversies about AST’s usefulness (Poole et al. 2004). Nonetheless, it is particularly appropriate for this study.

AST originates from structuration theory. Structuration theory springs from social theory on the make-up of human life and action. “Structure” refers to rules and resources that recursively reproduce social existence, that is, they cause new routines and are caused by new routines of human behavior (Giddens 1984). One key to structuration is the duality of structure, that it can exist both as a subjective understanding within social actors as objective, explicit statements, rules, or procedures too. The interpretation of structure by actors within a social system interacts with the formalized, objective forms of structure in a cycle of reciprocal causation that alternates between action and settled routine. Adaptive structuration theory extends structuration theory be postulating the role of advanced information and communication technologies (ICTs) in structuration through both their built-in structures and the structures that actually emerge when they are used (DeSanctis et al. 1994b).

This study had to find a way to account for both social and technical systems during team interaction and how a designated actor could influence them. This need fit AST well and drove its choice as the basis for the theoretical framework. We have long-known that many major causes of information systems failure stem from the failure to account for the technical sub-
systems—processes, tasks, and technology—in relation to the social sub-systems—people’s attributes and relationships, reward structures, and authority structures (Bostrom et al. 1977b). Some management information systems (MIS) theories target specific aspects of the socio-technical perspective, such as task-technology fit and theories of cultural fit with group support systems use, but these theories invariably attempt to predefine which aspects of social or technical systems will be most predictive of success so that one could figure out which inputs will be most necessary to produce successful IS usage. They can be very useful predictors once one knows that the most important factors in a given context are the ones they presume.

The premise of this study was that issues arise in the on-going process of team interaction. These issues change a team’s information and communication technology (ICT) needs, expose an opportunity for improvement in ICT usage, or reveal a lack in the ICTs being used. When this happens a team leader can facilitate a smooth and successful transition in ICT usage. This transition addresses the triggering issue, leading to improved team performance. AST has three strengths that recommended it in particular for this study, namely: 1) its global perspective, 2) its focus on appropriation, and 3) its ability to emphasize the influence of an actor.

First, AST has a global perspective on interaction between human groups and technology. It encompasses social and technical systems. Within this global perspective, AST differentiates task, people, organization and technology factors. This split allows one to differentiate changes related to ICT usage from those related to other factors. This capability serves this study’s focus on facilitating information and communication technology (ICT) usage.

Further, many of the more predictive and narrow, relevant theories can be integrated into this perspective. For example, task and technology are included as inputs to technology usage in
AST, enabling the capture of task and technology fit factors, if they are relevant. As a result, using AST to build the theoretical framework enables a broad exploration of this study’s topic, technology facilitation, which has seen limited research. The findings of this study should help identify which of the more predictive theories are most applicable to technology facilitation. These theories will be used to help interpret the study’s results and outline future research efforts in this area.

The ultimate outcome of this line of research is to develop an increasingly specific model of virtual team leadership. Such a model would embed other relevant theories within the global perspective of AST’s structuration framework. So doing, the model’s applicability can be extended to multiple levels, from micro to institutional (Poole et al. 2004). Examples of this approach already exist in the MIS literature: DeSanctis and Poole (1994b; 1990) developed a research model for investigating group support systems, and Jankowski and Nyerges (2001a; 2001b) developed a model that focuses on the application of geographic information systems in groups, organizations, and communities.

Second, AST describes appropriation, the process by which people use a specific ICT in a given context and time and their use leads to visible, new patterns of behavior, emergent structures (DeSanctis et al. 1994b). Appropriation describes a cycle of reciprocal causation. Reciprocal causation refers to settled structures being displaced by the emergent structures of appropriation, the emergent structures settling into the new standards, and then appropriation once again starting and producing new emergent structures. This cycling of change activity and settled patterns of interaction seems common to virtual work (Majchrzak et al. 2000; Maznevski et al. 2000; Montoya-Weiss et al. 2001) and points to the practical usefulness of using an appropriation lens.
Appropriation may occur at any time that people are using ICTs. This is unlike usage predictions in some other IS theories where the emphasis is an initial period of usage or adoption. Since this study’s scope is ICT usage at any point in team interaction, appropriation offers a useful perspective.

Appropriation follows a pattern of reciprocal causation with structures— the set ways of using ICTs. The periods when appropriation occurs are structuration episodes. By distinguishing between these episodes and periods of stable use, AST targets the focus of this study on the structuration episodes, enabling the screening out of large quantities of irrelevant detail.

Third, AST can be framed to emphasize either actors’ influence on structures or structures’ influence on actors (Poole et al. 2004). An actor perspective emphasizes who caused things to change. The actor perspective fits this study’s focus on the team leader as change agent.

2.2 Application of AST

Adaptive structuration theory describes structuration, the interaction process in which a group appropriates structures— technology, task, organizational environment and a group’s internal structure— to its own use (DeSanctis et al. 1994b). In this study we refer to these structures as technology, task, and people. Our people structure includes both the knowledge and experience with structures that individual team members have as well as the team-level phenomena like interaction routines and rules. As we explain later, we have set organizational context outside of the primary scope of this study.

The central change mechanism of adaptive structuration theory, appropriation, refers to the process of input structures, particularly technology, transitioning into stable, accepted new structures during VT interaction (Figure 2).
Figure 2: Conceptual Framework

Figure 2 provides a graphical representation of the literature review in this chapter mapped to the AST theory base. On a project level, a VT begins with team inputs, which are its initial structures or resources. These include three types: 1) task structures, 2) technology structures, and 3) people structures. These structures feed team interaction once the project work begins. They may interact with each other or be directly used in team interaction. As they are used in team interaction, technology, the focus of this study, becomes appropriated and used. Leaders take actions to enable this technology appropriation process, and the actions may vary according to three different project stages: 1) orientation, 2) production, and 3) termination.
Since appropriation may be constrained by organizational context, organizational context encompasses the process of team interaction and leader action. Finally, team interaction ends and team outputs are assessed. Some are task outputs directly attributable to the project goals. Others are people outputs produced during team interaction but not necessarily intended in the project goals. One such output could be lessons learned from the ICT appropriation process, and it might occur on individual, team, or organizational levels.

AST describes technology structure by two characteristics: their actual features and overall spirit. The actual features include intentional design choices, such as interface designs and supported data formats. The overall spirit includes the intention behind a technology’s design. It might be thought of as the intended purpose. The spirit may include several intentions, and in an actual tool the features may not agree with the spirit. Nevertheless, using a technology in accordance with its spirit should help the features make sense to the users and enable improved outcomes (DeSanctis et al. 1994a). We can trace an appropriation example of the arrow labeled number one, technology-only, across Figure 1.

Consider a case reported in one published study (Kayworth et al. 2000). A team began its task recognizing that each member had email and expecting that they could use email to handle many of their interaction needs from textual message exchange to file exchange. This was the technology input structure. As they began work, they discovered that email was unreliable for members in one location. The email servers would go down, arbitrary limits blocked messages, and other technical problems arose. Email could not handle the communication needs they expected it to handle. These conditions triggered the emerging email structure in team interaction. In one case, the leader took action, moving team communications to a Web-based team space and initiating use of chat sessions. This characterized a new emergent technology
structure state. This state carried through the end of the project, was identified as a success factor, and became the final technology structure state. Had the leader’s intervention not worked, he might have intervened again, producing one or more additional rounds of emergent structures.

As can be seen from this example, the structuration process can repeat. Appropriation makes changes to existing structures and new structures congeal from appropriation’s emergent ways of interacting. These new structures can then trigger additional appropriation. In a structuration theory, such as AST, this can lead to a causally ambiguous situation which impedes effective research into causes and effects (Poole et al. 2004). Solving this problem requires parsing structure and action into sequences (Poole et al. 2004). Addressing seven key requirements enables this parsing process and makes structuration theory suitable for empirical research (Poole et al. 2004).

The seven requirements for applying structuration theory are summarized in Table 3. Each is addressed in the following seven sub-sections in the process of developing the conceptual framework of technology facilitation within virtual teams (Figure 2). The conceptual framework served to organize relevant knowledge on technology use in virtual teams and leadership in virtual teams so that we could explore virtual team technology facilitation. It aided in developing the interview questions and in interpreting the data after the data collection was complete.
Table 3: Requirements for Applying AST, adapted from (Poole et al. 2004).

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Relevant Questions</th>
<th>Focus in this Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Structures</td>
<td>What are the relevant structures that constitute the system under study?</td>
<td>People, technology and task</td>
</tr>
<tr>
<td>2 Relationships</td>
<td>How do the relevant structures impact each other?</td>
<td>Technology-task, technology-people, and technology-task-people interactions</td>
</tr>
<tr>
<td>3 System</td>
<td>What is the general setting in which structuration occurs? What actions characterize its operation and actors’ perceptual understanding?</td>
<td>Conceptual framework of VT interaction</td>
</tr>
<tr>
<td>4 Moves</td>
<td>What are the activities by which actors produce structures?</td>
<td>“Structuring” episode</td>
</tr>
<tr>
<td>5 Impact on Context</td>
<td>How is context shaped?</td>
<td>Identification of new structures and relation of them to VT outcomes using critical incident technique</td>
</tr>
<tr>
<td>6 Actors</td>
<td>What is the role of the intelligent agents driving structuration?</td>
<td>Focus on the VT leader</td>
</tr>
<tr>
<td>7 Power</td>
<td>How are power dynamics influencing the process?</td>
<td>Awareness of VT leader – team member power relationship</td>
</tr>
</tbody>
</table>
2.3 Structures: Inputs to Appropriation

In addition to technology, AST includes task, people, and organizational context (DeSanctis et al. 1994b). In that structures represent rules and resources developed in social routines (Giddens 1984), the specific characteristics of people, technology, and task define them as structures and define organizational context’s constraints. This study takes IS development VT projects as its domain. Structures become important in this domain when they can affect IS development work—the purpose of interaction—and can change during a project—the timeframe. Several studies have examined such structures in relevant contexts and help identify important ones to address in designing a VT.

Since our focus was leadership, particularly technology facilitation, the structures of interest were the technology, people, task, and organization structures that primarily enable technology facilitation. Put differently, these were the structures that the leader can leverage during team interaction to influence technology use. They were also the structures that mediated other people and task structures as they relate to technology facilitation. The subsections below identify these.

2.3.1 Technology Structures for Facilitating Technology

The technology structures of virtual teams are the information and communication technologies (ICTs) available to the VT. ICTs include audio conferencing, email, personal communications devices such as phones and cell phones, scheduling/calendaring systems, groupware, and document management systems (Becker et al. 1999; Quereshi et al. 2001). The set of ICTs available to a particular VT can aptly be termed a VT technology “toolkit” (Suchan et al. 2001). Under this definition, one particular suite of applications, such as Lotus Notes, might include multiple ICTs. We call this an ICT suite. We recognize that it may be difficult to
distinguish all of the ICTs in an ICT suite. To the extent that they can be differentiated, ICT used herein refers to each application in a suite. Thus, a team might appropriate only a portion of the ICTs available in a suite of applications. This level of granularity helped in identifying the options available at various points in time.

There are some ways that current literature enlightens ICT choice and usage. ICTs may differ in their physical accessibility and reliability within a given VT, and they may also differ in their capacity to enable different communicative goals (Dennis et al. 1999; Scott 1999; Te'eni 2001). One scheme based on empirical research breaks down three ICT functions by core tasks: communication support, process structuring, and information processing (Zigurs 1993). In this scheme, communication support enables transmission of data between team members.

Prominent examples of ICT often used for this include email, phones, chat, audio conferencing and discussion boards. Process structuring focuses on the VT interaction process, including features such as agenda setting and enforcement, document storage and versioning, facilitation, and recording interaction. Many more complex ICT packages, including Computer-Aided Software Engineering tools, include features that can be used for process structuring. Information processing enables gathering, sharing, aggregating, or evaluating information. Many modeling-specialized analysis tools such as optimizers or debuggers and decision-support tools such as brainstorming and polls provide features for information processing capacity in VTs. Information processing ICTs can help enable critical interaction functions, such as contextualizing knowledge (Ahn et al. 2004).

Given the exploratory nature of this research, we thought it might be useful to differentiate ICT in VTs by these capabilities; however, initial questions were intentionally broad to avoid guiding VT leaders to these choices of framing. These capabilities were only brought in
as probes when relevant. They helped clarify in instances in which one ICT may have had multiple capabilities. In such cases research suggests creative VT leaders and teams may find ways to use the features to expand an ICT beyond its given capability(ies) (Quereshi et al. 2001), and we did not want to miss this possibility.

We explored the technology structures by asking the VT leaders what their teams had available and what they were actually using before, during, and after each critical incident. When relevant to a particular critical incident, we also asked what purpose the ICTs served in interaction.

### 2.3.2 People Structures for Facilitating Technology

Specific to the domain under study but without regard to VT leaders, people structure characteristics include personality (Gorla et al. 2004; Kaiser et al. 1982), culture (Sarker et al. 2004), and knowledge (Blackburn et al. 2003). In fact many demographics and general fit issues between a leader and his team can impact performance (Kirkman et al. 2004b). In studying VT leader technology facilitation, we sought the people structures that VT leaders may employ to improve interaction through technology use. These structures enable leaders to garner the value of diversity represented in the demographics of a team (Ancona et al. 1992). Thus, we focused on roles, ICT knowledge, and change incentives rather than team member personal characteristics or traits that would be unlikely to change in the scope of one project.

Some evidence supports the proposition that the roles may be designed by and can be influenced by the VT leader (e.g. Majchrzak et al. 2000; Mantei 1981). A VT leader could shift responsibilities from one person’s role to another’s or create new ones. The role design affects interaction and enables work in IS development project teams (Gorla et al. 2004; Mantei 1981; Mennecke et al. 1998). For instance, a software development team would likely include a formal
leader, systems analysts, and programmers (Gorla et al. 2004). With those roles come assigned responsibilities, such as using a specified ICT, cooperating with a given sub-group, or sending progress reports. Members might compensate for each other, taking on informal roles as advisors or volunteering to take on additional responsibilities as interaction develops.

Changes in roles and their responsibilities may be more prevalent under some VT conditions. Factors that may indicate how much roles and responsibilities will and can change include the size and stability of the VT. A smaller team may require one person to handle multiple roles simultaneously (Gorla et al. 2004). An *ad hoc* VT is a less-stable form of VT, formed around a project and disbanded before the next project, a condition in which a leadership role tends to emerge (Yoo et al. 2004). People have been found to volunteer for roles in *ad hoc* VTs as they become important, including leadership ones (Yoo et al. 2004).

Team members’ ICT knowledge is likely to influence how they perceive ICT and their actual use of it (Wheeler et al. 1996). This knowledge has technical and social aspects (DeSanctis et al. 1994b; Knoll et al. 1998), which can be understood as knowing how to operate an ICT and knowing how its use will impact team interaction, respectively. In IS adoption literature, these aspects map to ease of use and usefulness, knowledge that enables acceptance of a technology (Davis 1989) and feed computer self-efficacy, beliefs about one’s capabilities at using ICTs (Compeau et al. 1999). Considering computer self-efficacy theory, it stands to reason that the more ICT knowledge and the more successful experience a team member has, the more confident and less anxious a team member would be during virtual interaction when change is necessary and the less trouble they would have participating as a result. VT leaders can attempt to augment team members’ ICT knowledge through training or other means (Wheeler et
al. 1996). Such a change might lead to supporting current ICT in use or enabling the addition of a new ICT.

VT leaders may use change incentives to get members to accept a new ICT structure. They can be positive or negative, and they might be as formal as compensation bonuses or cuts or as informal as praise or criticism. As such, they can critically influence how an IS development team interacts (Hertel et al. 2004; Perlow 1999) and how work groups decide to use technology (Reinig et al. 1996). The ability to give change incentives likely falls within the VT leaders’ purview to lesser or greater degrees. For example, they might depend on organizational boundaries that determine formal authority to affect compensation and promotion. Nevertheless, some examples from research suggest that simple communicative acts between a leader and a team member, such as personal recognition or sanction, affect technology use and team interaction (Edmondson et al. 2000). These appear to be more universally available to VT leaders even if organizational context limits other change incentive authority. Since some form of change incentive will likely always be available and may have a substantial impact on the outcome of a technology facilitation episode this is a third people structure for VT leader technology facilitation.

One might also consider member demographics as a critical people structure in teams (Kirkman et al. 2004b), but demographics appear less likely to influence team interaction in virtual teams due to a lack of standard cues on which stereotyping relies (Carte et al. 2004).

We explored the people structure by asking the VT leaders what the initial setup- roles, size, dispersion, the nature of members’ ICT knowledge and whether members fell into sub-groups on this dimension, etc.- of their VT project was, if and when any roles changed in each
critical incident, whether incentives were used and how, and what other people changes took place during each critical incident, such as hiring, delegating, or firing.

### 2.3.3 Task Structures for Facilitating Technology

Work goals are the intermediate and final targets that guide the task-oriented labors of the VT. Research has shown that completion of these goals effectively motivates ICT choice (Straub et al. 1998). In the case of IS development projects, intermediate work goals can be manipulated by a leader and impact the way a team interacts and performs (Abdel-Hamid et al. 1999; Hertel et al. 2004).

A second aspect of task structure for facilitating technology is work methodology. A work methodology is a defined process by which the VT interacts in pursuing its goals. In terms of technology facilitation in an IS development team, work methodology implies different interaction requirements (Glass 2004). The VT leader may be able to manipulate methodology in the process of technology facilitation or fit ICT to methodology and goals (Beise et al. 2004). Some efforts have been made within the software development industry to help IS development VTs better understand and react to required changes in methodology and goals mid-project. For example, in Carnegie-Mellon’s Software Engineering Institute’s popular Capability Maturity Model (CMM) for rating such capabilities, a level-5 rating indicates the ability to handle adaptation of work goals and methodology during a project. It seems natural that a high CMM rating would relate to a VT’s intentional capacity to examine task structure and change it or the technology in relation to it when necessary.

We explored task structures by asking about the methodologies followed in the projects, the schedule and how it influenced the work, and the project milestones and other procedural
status indicators. As we found relevance during the interviews, probing questions about the role of task during critical incidents were also asked.

2.3.4 Organization Context

Organizational context does not seem manipulable by VT leaders. Based on prior research we expected it to be relatively constant across the timeframe of a VT project. We believed the impacts of constraints imposed by organizational context would be captured in the technology, people, and task structures. In order to limit the complexity of this study to a manageable level so that the interviews could be conducted in two hours, this study removed organizational context as a direct structural input. Evidence from VT research supported this choice, noting that even when teams attempt to manipulate organizational context, it does not itself change in the course of one project (Majchrzak et al. 2000). Since organizational context may still exert some influence on the appropriation process even if it cannot interact, organizational context was modeled as a container around team interaction (Figure 2). Since task and people structures interact and temper technology appropriation in VTs (Powell et al. 2004), they offer potential levers for VT leader manipulation and were kept in the model as primary input structures for examination.

We captured a variety of data on organizational context including the number of organizations involved in each project and any relevant policies or rules that impacted specific critical incidents. Where interesting phenomena arose regarding organizational context, they were probed during the interviews.
2.4 Relationships: Interactions Among the Structures

The relationships between structures indicate how structures may complement or contradict each other. In Figure 2 the dotted and solid arrows between technology, task and people indicate the possible structural relationships we expected to be important to technology facilitation. The four numbered, solid arrows indicate (1) the core structure, technology, and its relationships (2-4) that specifically pertain to this study. The three numbered relationships are: 2) technology-task interaction, 3) technology-people interaction, and 4) technology-task-people interaction (Figure 2). The example given in section 2.2 traced arrow one through Figure 2. Task and people, as well as, the task-people interaction relationship were excluded since they posit an impact on technology use absent technology.

As an example of how structural relationships are important, there are many possible contradictions and complementary relationships between people and technology. Team members might have in-depth knowledge of an ICT not being used. Their knowledge might direct them to suggest its use. This might guide a VT leader in technology facilitation. If the same situation were framed such that members had no ICT knowledge, efforts at technology facilitation would likely be plagued by difficulty. In another situation, roles might be structured for hierarchical reporting on set time schedules. Such structuring might fit well with a top-down scheduling system. Conversely, roles might be more independent and self-guided. A top-down scheduling system that did not enable the independence built into the roles would likely be hard to support or introduce in such as case. Rewards could include a bonus or other promotion-enhancing offers for contributing to an organizational portal. Facilitating the portal’s use would likely be much easier in such a case. The opposite would also be likely, that penalizing contribution would lead to disuse.
These are a few examples of how people and technology structures may interact and impact technology facilitation. There are many additional possibilities here and in technology-task and technology-task-people interactions. This study aimed to identify the important structural relationships where possible. This was done by mapping the categorized structures to each other where they existed in critical incidents and looking for patterns to interpret. An *ad hoc* analysis was done to identify key relationships. This deliverable provides a foundation for developing a theory of VT technology facilitation and suggests future research directions. An *ad hoc* analysis was done here, because it is difficult to map and identify patterns of non-role, process interactions in critical incidents technique data. The sub-sections below summarize existing literature relevant to each relationship.

**2.4.1 Technology-Task**

The technology and task structure relationship in VTs has not received much attention (Powell et al. 2004). In the larger frame of information systems (IS) and group support systems (GSS) research the relationship has been characterized as a fit (Goodhue et al. 1995; Zigurs et al. 1998). Characteristics of one can improve the other if they agree as in a negotiation task and GSS features (Mennecke et al. 2000) or goal-setting and specific features of ICT used in VTs (Huang et al. 2002). In these examples, technology is assigned to task, fitted to it through selection, in order to create a complementary relationship.

The task may also be fitted to the technology. Some evidence from VTs facing email problems support this option, especially when hard limits such as reliability and availability stopped usage of initially preferred ICT options and the task was refitted to a different ICT (Kayworth et al. 2002).
2.4.2 Technology-People

Technology and people structures provide likely cause for interaction. In the case of the people structure, VT members must use ICT while fulfilling their roles. Their desire to use the ICT in a given situation will likely vary according to the benefits they perceive they will get from use (Grudin 1988). Adoption theories in the IS literature capture much of this perception through ease of use and perceived usefulness constructs (Davis 1989).

In the reverse direction, VT ICT characteristics may impact the people-technology relationship. Richness and synchronicity characterize VT ICT in terms of people’s communication needs for fulfilling roles (Martins et al. 2004). Richness enables a broader set of communicative cues (Daft et al. 1986) and synchronicity enables faster feedback. Together they enable communication necessary for production, group well-being and member support (Dennis et al. 1999). Coupled with availability and reliability, these characteristics of ICT help determine how users will experience ICT, which likely impacts the benefits or rewards they feel they get from use. That experience yields affective responses such as satisfaction (Martins et al. 2004). It seems likely that the more satisfaction, the more likely users will make the effort to try and use the ICT.

2.4.3 Technology-Task-People

Three-way interactions between technology, task, and people structures present a challenge for interpretation due to the many possible configurations. Some examples from existing research show this complexity. Within VTs ICT might serve roles within the work methodology, as a proceduralist and recorder, gate keeper, and information/opinion seeker (Zigurs 2003). A VT leader may find ways to apply ICT to additional VT roles within the task
goals and methodology. As he does this, people’s roles within the methodology will likely change (Majchrzak et al. 2000), changing interaction needs (Mantei 1981). These changes might require further manipulation of ICT in use, modification of goals, assessment of rewards, acquisition of ICT knowledge, and, possibly, changes in the work methodology.

An example comes from software development VT literature. In one case, a project manager assigns roles during VT interaction internally to team members and externally to consulting experts depending on the ICT’s ability to include them and the methodology’s level of stability (Dustdar et al. 2002). In the same case, ICT information processing tools affect better awareness of work methodology issues and status of responsibility completion on the part of the VT (Dustdar et al. 2002). Status of completion can be used for recognition and sanction, and the VT might use work methodology awareness to become more flexible in task restructuring and technology usage. Flexible task and technology structures enable people to take on roles and responsibilities voluntarily, based on expertise or interest rather than assignment, leading to potential gains in work goal accomplishment (Dustdar et al. 2002).

2.5. System: Process of Work: Communication Over Time

The “system” is team interaction, the setting for technology facilitation (Figure 2). The system of teamwork is interaction, that is, communication over time. Fundamentally, communication is the interactive process underlying all human social activity and is critical for the accomplishment of collaborative work (Winograd et al. 1986). Communication exists in a consensual domain in which participants share understandings that enable coordination of messages and their accurate production and interpretation (Whitehead 1956; Winograd et al. 1986). In virtual teams, this interaction is computer-mediated communication over time.
(DeSanctis et al. 1997; Martins et al. 2004; Powell et al. 2004), and the understandings must be supported in the information and communication technologies.

IS development VTs’ system likely faces an acute need for on-going improvements in communication. It is characterized by tight time lines and projects requiring some level of “friction”– productive conflict (Armour 2004). The unpredictable nature of the friction makes it likely that communication needs will change over time in IS development teams. In AST, structural changes emerge over time through numerous structuration episodes (Tyre et al. 1994). In VTs these structural changes could have a positive or negative impact on performance depending on whether they support better team interaction. The action of the structuration episodes is to create emergent structures from the initial structures. Over time, these may be shaped into new emergent structures and so on. At the end of a team’s project, there is a final state for the technology, task, and people structures. This structural level of change over the span of a VT’s project is pictured at the bottom of Figure 2.

2.5.1 Virtual Team Group Development and Project Progress

Work group development has long been studied in the management literature and can be conceptualized in sequential stages that follow the progress a team makes on its work (Tuckman 1965). More recently, research has suggested that only two developmental modes exist in a punctuated equilibrium pattern (Gersick 1988), and alternately, that prior stage research still applies (Wheelan et al. 2003). Virtual team studies have offered partial support for stages (Rutkowski et al. 2002; Suchan et al. 2001), for punctuated equilibrium (Jarvenpaa et al. 1999; Maznevski et al. 2000), and for continuous, non-punctuated development (Huysman et al. 2003; Majchrzak et al. 2000).
Employing a stage model reinforces the directionality of VT interaction as a means for project progress. Emphasizing the importance of project progress helps in isolating contributions to goal achievement. It also serves as a necessary means for differentiation of systematic structural changes at different times (Poole et al. 2004). Given that some VT literature ambiguity exists about the presence or absence of stages, we chose a simple three-stage model to capture the necessary detail for this study based on the literature on work team leadership (Hackman 2002). We term the three stages (re-)orientation, production, and termination. They are pictured in relation to team interaction and leader actions in Figure 2.

Virtual teams need initial group development focused on initial introductions to and appropriations of the input structures (people, technology, and task) to build shared understanding and shared language (Powell et al. 2004). This stage is orientation. Following orientation, VTs enter production. In production, the VT leader facilitates team interaction to guide its direction and maintain momentum. A final stage for project termination or “wrap-up” follows or is concurrent with product delivery. It offers closure on lessons learned and seems optional, but it offers opportunity for increased learning and improved quality (Rutkowski et al. 2002). We call this termination. The VT leader can guide the reflection and learning when this stage occurs.

Adaptive structuration theory holds that technology appropriation can occur throughout the life of a group (DeSanctis et al. 1994b). When it occurs, appropriation represents shifts in team interaction (DeSanctis et al. 1997). This cycling of time using accepted structures and interacting in one way and time appropriating new structures leading to emergent interaction patterns can follow at least two courses. First, it can be linear, establishing structures in orientation and tweaking settled structures to maintain momentum during production and
termination. Second, it can be circular, revisiting the orientation stage when momentum flags in order to introduce major structural revision if a team is already in production or termination. From this latter perspective, orientation can recur. Accordingly, (re)orientation, production, and termination do not strictly correspond to sequential stages. We expected that re-orientation would spring from production and be followed by production in most cases in which it might occur, simply due to the energy expenditure necessary to reinitiate orientation and the probable lack of benefit for re-orientation if the project is already in termination.

In some literature, these stages might also be termed modes that may occur in varying sequences as in production modes in Time, Interaction and Performance theory (McGrath 1991). We considered mode and stage interchangeable as characterizations of project progress within a VT’s system.

To explore stages, we asked the VT leaders at what point in their projects the critical incidents occurred, how long each critical incident lasted, and what sort of process the critical incident went through, such as a re-orientation stage and then production again.

2.6 Moves: The Structuring Episode as Appropriation Vehicle

In response to the difficulty of empirically applying AST, some researchers have attempted to improve the capability of measuring global aspects of the structuration process (Chin et al. 1997; Salisbury et al. 2002). While their global scales offer useful tools to determine whether and how faithfully a structure has been appropriated, they do not tap into the process by which a structure is appropriated. It seems that this is a particularly difficult task in applying AST since many AST studies of ICT in groups have failed to adequately account for intermediating processes (Reinig et al. 2002), with some notable exceptions (e.g. Majchrzak et al. 2000; Maznevski et al. 2000).
Two fundamental approaches characterize technology appropriation moves or actions as they relate to the VT system. These are the proactive and reactive approaches. They revolve around an outcome orientation or a problem orientation (Kelly et al. 1998). A proactive technology appropriation approach may follow the team members discovering new possibilities for achieving outcomes (Tyre et al. 1994). In such a case, using an additional ICT or modifying their use of existing ICT would enable better interaction and thereby enhance project outcomes. A reactive approach may follow discrepant events (Majchrzak et al. 2000; Tyre et al. 1994) as in the following example. As the VT interacts, team members use available ICT to accomplish their project. Team members may find that the ICTs they are using do not offer what they need. This becomes a problem they must address. In an orientation stage, this might lead to further exploration of the ICTs in use whereas in production they might be more likely try to adapt and compensate for missing or unfamiliar features (Huysman et al. 2003). A reactive approach may lead to scrapping a given ICT in favor of an alternative, adding a new one, or perhaps sticking with an ill-fitting ICT and adapting other structures to accommodate it (Huysman et al. 2003).

Proactive or reactive appropriation actions occur within structuration episodes, the windows of opportunity in which structure can change (Tyre et al. 1994). We proposed the structuring episode as the key vehicle for appropriation during technology facilitation. The structuring episode is a structuration episode in which the VT leader intentionally attempts to influence structuration by taking one or more actions. The distinction between a structuration episode and a structuring episode is that a structuration episode simply describes what occurs, a structuring episode gets into the management of what occurs. As structuration episodes imply only that the process of change has taken place, studying structuring episodes offers an extension to our current understanding of how the process of change in AST works. The structuration
episode is an event with a beginning, a middle, and an end. A structuring episode has the same time points but adds the distinction that some actor is intentionally manipulating structuration. This study focused on structuring episodes. To be adequately identified for research purposes, we needed to understand how and when a structuring episode starts, how and when it ends, and what happens while it occurs. The successive three sub-sections address these issues, and we chose our methodology, critical incidents technique, specifically to enable the identification and sampling of structuring episodes.

2.6.1 Triggers of Structuring Episodes

We expected that at least two types of triggers could provide impetus to start the structuring episode. These have been noted above in relation to the fundamental approaches that may characterize appropriation actions. The first type is reactive in nature and springs from exceptions from the norm, noted variously as interruptions or discrepant events (Tyre et al. 1994), discrepant events (Majchrzak et al. 2000), or “episode[s] of project dissonance” (Rutkowski et al. 2002, p.225). These discrepant events can result from any activity impacting technology use. Drawing on the conceptual framework (Figure 2) these activities have four possible origins: (1) technology alone, (2) technology-task interaction, (3) technology-people interaction, or (4) technology-task-people interaction. A “technology alone” trigger can be understood as changes in ICT reliability or availability that cause discrepancy. The technology-people, technology-task, or technology-people-task interaction trigger can be understood as changes in the fit of people and task structure with ICT in use that cause discrepancy or disruption to team interaction.

The second type is proactive in nature and originates with intentional management or leadership choices (Orlikowski et al. 1995) spurred by “new discoveries” (Tyre et al. 1994).
Such triggers may emerge out of on-going learning from experience during a VT project (Hollingstead et al. 1993). The proactive type shares the same possible origins as reactive triggers. For instance, a technology-origin proactive trigger includes a leader discovering an ICT with equal functionality but much better availability and reliability and deciding to introduce it.

Either type of trigger requires that the VT leader interpret it in such a way that she decides to take action. Some research suggests the VT leader weigh task appropriateness of the additional ICT against the added confusion and complexity of its introduction in deciding on a course of action when adding a new ICT is in question (Pauleen et al. 2001), but the process of decision is still unclear and raises questions. How does a VT leader decide to act? What conditions merit action? What distinctions among triggers are there beyond proactive and reactive? This study will produced a categorization of triggers to answer these questions.

2.6.2 VT Leader Technology Facilitation Actions

The virtual team literature points to several technology facilitation actions leaders take. VT leaders support ICT appropriation through working around communication problems using available options in the extant ICT and encouraging use of existing ICT (Archer 1990; Kayworth et al. 2002; Sarker et al. 2003), introduce new ICT, making it physically available, initiating initial use and training (Bell et al. 2002; Kayworth et al. 2002; Sarker et al. 2003), and block ICT appropriation by discouraging use and making it physically unavailable (Kayworth et al. 2002). These three behaviors provided assurance that a variety of action possibilities exist. One of the questions addressed in this study arose here: What are the types of technology facilitation actions that VT leaders take? The categorization of VT leader technology facilitation actions addressed this.
2.6.3 The End of a Structuring Episode

The results of the structuring episode at its end might be marked by use, changed use, or discontinued use of the ICT(s) targeted. They may also be marked by more indirect measures of appropriation in AST: faithfulness, attitudes toward use, and consensus on appropriation (Salisbury et al. 2002). These are possible outputs of a structuring episode based on theory. Are there distinct types of structuring episode ends in VT leader experience? What are they? To explore the end of structuring episodes, we asked the VT leaders how and when each critical incident ended and what structural changes occurred as a result of each episode. Some probe questions also helped evoke a response to how leaders decided that they have done enough and what evidence they had that the episode concluded and had some impact. The categorization of structural changes resulting from structuring episodes addresses the ends of structuring episodes.

2.7 Impact on Context

The impact on the context refers to the influence on the encompassing environment in which the system exists. In lay terms this means what performance outcome did the change in team interaction have? This is different from the consideration of the contextual antecedent factors including structural changes noted in the preceding sections. Here the consideration is how structuration impacts the context, forming the closed circle of reciprocal causation inherent to AST. In the broad view, a VT’s context is an IS development project assignment. At the point when technology facilitation takes place, we expected the project would have to be in progress. Since the contextual influence’s examination centers on understanding the outputs from structuration and how they impact the context (Poole et al. 2004), the focus here is how the changed structures impact project progress and, ultimately, team performance. Adaptive
structuration theory identifies two types of outputs from structuration: “task” outcomes and structural outcomes (DeSanctis et al. 1994b). Structuring episodes produce new technology structures. These new technology structures, children of technology facilitation, take effect within IS development VTs involved in a project. These structural changes are the end of the structuring episode and not part of the contextual impact. We referred to them as the “changes” in our methodology and analysis. On the other hand, the “outcomes” relate directly to contextual impact.

At least one ideal outcome of technology facilitation is improved project progress, a “task” outcome. Consequences of a VT leader’s technology facilitation may not be intentional or may be detrimental to project progress. For example, he might accidentally block a technology appropriation that probably would have been beneficial (Kayworth et al. 2002). Task outcomes impact progress on a given, specific project in some way. Ultimately, task outcomes impact project outcomes that include being on-time, delivering within specification, product quality, satisfaction, and finishing within or under the budget to name a few.

As structures relate to ways people interact, structural outcomes relate to people and how they behave. These might include any number of possibilities, such as job satisfaction, quality of work life, and learning to name a few. They too can impact project progress, but their impact may be more general and long-term. They may have different implications at different levels of analysis from individuals to teams to organizations.

Take learning for example. Structural changes become experiences gained through structuring episodes and can be seeds for learning about ICT use and needs (Reinig et al. 2002). Research on this important VT outcome is currently lacking (Martins et al. 2004), though some evidence points to the nature of learning opportunities at individual, team, and organizational
levels. On an individual level, going through the appropriation process can lead to improvements in personal knowledge, skills and abilities (Blackburn et al. 2003). A VT leader and the team members can take away a better understanding ICT and when and how to use it. At a team level, work teams often experience improved performance when allowed to work together on multiple projects, a team-level feedback loop based on learning from prior interaction (Hackman 2002). IS development VTs might learn an optimal mix of ICT that fits their needs over the course of a given type of project, making subsequent similar projects more efficient. Likewise, organizational knowledge can be built through VT interaction (Griffith et al. 2003) and well-designed computer-aided systems (Goodman et al. 1998), suggesting a potential organizational level learning output (Furst et al. 1999). An organization might learn that its IS development VTs need new norms or rules or that they need a different ICT toolkit to improve performance. While this learning may take place, its fruit may not show up in the specific, immediate project in which it occurred. For example, some research has found that leaders take up to nine months to integrate lessons learned into their work (Hirst et al. 2004). As a result, VT leaders may be able to identify what was learned from structural changes, but their ability to tag these lessons to improvements in project progress and ultimate project outcomes cannot be expected in the scope of one project. This leads to the distinction of other outcomes of technology facilitation conceptually (Figure 2).

Each outcome is contingent, and the literature is very limited regarding what outcomes appropriation in VTs may have. This is why we depicted the outcome relationships with dotted lines in Figure 2. For example, the project may fail and be terminated prior to most project outcomes materializing. Technology facilitation outcomes are similarly contingent. In the learning example, individual learning may not take place due to a lack of support or failure to
reflect and find lessons in the experiences. Teams may be split after a project, removing the opportunity to become more efficient as a group, and there may be insufficient structural support to ensure knowledge capture at an organizational level. So, there was no way to be sure that the categorizations of outcomes we proposed made sense, they were presented as possibilities for exploration and interpretation of the data found in this study.

The outcomes form the purpose of technology facilitation and enlighten technology facilitation’s impact. The main question here is: What are the outcomes of technology facilitation? The categorization of outcomes answered this question.

2.8 Actors: Virtual Team Leaders

The actors are the humans who choose to “produce and reproduce structures” (Poole et al. 2004). In this research, the actors were the formally assigned VT leaders. Their role under examination was that of technology appropriation facilitator.

2.8.1 Leader Understanding of Their Context

Virtual team leaders must interpret a wide variety of information in order to act. More so than FtF IS development team leaders, they find themselves in situations where they must “straddle” or bridge cultural, temporal, and other boundaries (Nicholson et al. 2004). It is not surprising then that researchers characterize the larger VT leader role as behaviorally complex (Kayworth et al. 2002). Key to theory of behaviorally complex leadership is the idea that successful leaders perform multiple leadership sub-roles simultaneously (Kayworth et al. 2002). They must develop the ability to filter information, find the important issues for a given role, and address them at critical moments when changes can be affected efficiently (Nicholson et al. 2004). In the role of technology appropriation facilitator, knowing ICT and its relationships with
people and task structures has been noted as imperative to enable filtering, finding, and tactful intervention (Grudin 1988).

VT leader knowledge of ICT is tricky. Knowing many of the technical specificities of an ICT may impede successful leadership and may not correlate with knowing the communicative value humans can derive from it. The communicative value intended in an ICT’s design comprises its spirit, wherein communicative value derives from people interacting in designed ways to accomplish tasks. The spirit of an ICT and its relationship with people and tasks demands a less technical sort of knowledge. It is more social and interpersonal and is recommended for VT leaders to be successful in the IS development project domain (Klenke 1997).

Many ICTs may share the same “spirit” or can be adapted to serve the same “spirit,” potentially satisfying the same core group communication needs though the actual features differ. Specific features may include accessibility and reliability issues that differentiate otherwise equal ICTs. As a result, a VT leader will probably need to understand some of the specific features as well as the more social and interpersonal and be able to weigh these factors against each other and their VT’s context.

To explore what VT leaders know, we asked about their beliefs regarding technology facilitation. These beliefs were then categorized in a deliverable to address VT leaders’ understanding of their context.

2.9 Power: VT Leader Authority

A structuration study must undertake an examination of the power dynamics within the social system as power imbalances can strongly shape structuration (Poole et al. 2004). Poole
and DeSanctis emphasize this point to reinforce the idea that power impacts can show up in any number of ways during the process of structuration. These impacts can be pervasive.

Power relations between a formal VT leader and his or her team may seem fairly straightforward. On a simple level, the formal leader has some positional authority to enact structuration, and the VT members must follow that lead (Edmondson et al. 2000). This is one possible formal power structure. The nature of power in this scenario is positional, which may include legitimate power to lawfully make decisions, reward power to motivate compliance, coercive power to punish non-compliance, and information power to control information used by VT members (Dubrin 2004).

In another scenario, there may be more than one formal leader, especially when multiple organizations are involved in a VT as in offshore software development projects (Nicholson et al. 2004). In such a case, interplay between the leaders might lead to power imbalances, or lack of shared organizational norms might lead VT members from differing organizations to value each leader’s authority differently (Nicholson et al. 2004). VT power relations may also be effected by the relative lack of social cues passed along by the ICT. In their absence, adherence to formal power structure might wane (Avolio et al. 2000).

Due to its potentially pervasive influence when present and the primary interest in this study of understanding how technology facilitation works, power relationships were explored across the preceding questions. They were not explicitly explored in the interview questions. That is, we expected that any important power effects would show up in VT answers when they were important. This was found true in the pilot interviews. The results of power influences were added where appropriate to the categorizations.
2.10 Summary of Literature Review

The previous sections of this chapter presented findings from most of the 86 articles we found that related directly to the seven focal areas necessary to address in applying AST (Table 4). In this section we demonstrate how this study fills an important gap in this literature. We made a distinction between the studies that were specific to virtual teams and empirically drawn from field settings, because prior literature pointed to a strong need to conduct virtual team studies in field settings in order to ensure the validity of the results. We found a total of 22 of these studies. In all, there were very few studies that address who the actors are in appropriation and what moves they make. Only one field study even tangentially addressed each of these areas, and those two studies were very limited. The first examined a single VT leader’s role in researching and writing a governmental business plan (Pauleen 2003). It provides only a single case from a single perspective. The second looked at the moves any member of a VT can make to improve interaction in knowledge-producing tasks (Kruempel 2000). This study used a content analysis of only one discussion using one ICT of a long-standing, voluntary committee and did not focus on the leader moves. Other than these two studies, no study we found has addressed leader moves and role in virtual teams using empirical, field data.

The majority of studies we found were in either the group-support systems or computer-mediated communications literatures and were conducted in laboratory settings using undergraduate students. Many of the articles were not even empirical studies but conceptual papers. Many (27 articles, 31%) of these articles took a deterministic view, linking inputs directly to outputs, or they (27 articles, 31%) focused on aspects of team interaction, the system. Eight articles mentioned situations in which leader actions critically impacted team interaction mid-process, either successfully or unsuccessfully. No empirical study has looked at how VT
leaders facilitate technology use. This study addressed this gap, focusing specifically on the actors, VT leaders, and their moves, technology facilitation actions.

**Table 4: Summary of Articles Found by Applicable AST Focal Area**

<table>
<thead>
<tr>
<th>AST Focal Area</th>
<th>Applicable Topics Found in Articles - (sampling of)</th>
<th>Number of VT Field</th>
<th>Number of Other Useful Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures</td>
<td>Team member characteristics (Gorla et al. 2004; Kirkman et al. 2004b; Knoll et al. 1998)</td>
<td>7</td>
<td>20</td>
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<tr>
<td></td>
<td>Task methodologies (Glass 2004; Marks et al. 2000)</td>
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<td></td>
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<tr>
<td></td>
<td>ICTs and Communication channels (Qureshi et al. 2001; Te'eni 1992)</td>
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<tr>
<td>Relationships</td>
<td>Technology and people synergies (de Vreede et al. 1999a; de Vreede et al. 1999b)</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Technology and task synergies (Zigurs et al. 1998)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actors</td>
<td>Effective leader characteristics (Kayworth et al. 2002 VT Leadership)[Pauleen, 2003, dissertation VT Leadership]</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Managerial control style [Piccoli, 2003, dissertation VT Leadership]</td>
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<tr>
<td>Focal Area</td>
<td>Applicable Topics Found in Articles - (sampling of)</td>
<td>Number of VT Field Studies</td>
<td>Number of Other Usefull Articles</td>
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<tr>
<td>Designated vs. emergent or dispersed leadership (Tyran et al. 2003)</td>
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<tr>
<td>Moves</td>
<td>Proactive vs. reactive strategies (Kelly et al. 1998; Tyre et al. 1994)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Contextual Impact</td>
<td>Movement to co-sourcing (Kaiser et al. 2004)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Changes in situated learning (Robey et al. 2000)</td>
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<td></td>
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<tr>
<td>Power</td>
<td>Cross-organization issues (Johansson et al. 1999) Presence and authority (Dennis et al. 2003)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>22</td>
<td>64</td>
</tr>
</tbody>
</table>
2.11 Summary

The research framework for this study was based on adaptive structuration theory (AST) and followed new guidelines for the successful application of AST in empirical research. The new guidelines require that seven focal areas be addressed in an AST study. Fitting what is known to the new guidelines led to the identification of gaps and numerous areas of focus for this investigation. In all, we found 86 studies relevant to the seven areas. Twenty-two of them were based on empirical, field studies of virtual teams. No study has explored the role of the VT leader as a technology facilitator, and only two studies have addressed the actors and moves involved in technology appropriation in VTs. This study directly addressed this gap of knowledge about actors and moves in VT appropriation, specifically, the VT leaders and the actions they take in the process of technology facilitation.
CHAPTER 3: RESEARCH METHODOLOGY

3.0 Chapter Overview

This chapter details steps used for operationalizing the research questions to produce deliverables. Subsections attend to the overall research design, the sample context and selection, the data collection and analysis methods, and lessons from completed pilot studies.

3.1 Research Design

This study used data collection and analysis methods provided by the Critical Incident Technique (CIT). CIT provides a means to intensively examine VT leader actions in real-life contexts without any manipulation, an important concern in IS research (Dubé et al. 2003b). Its key elements for this study are a narrow focus on intensely examining behavioral requirements of work roles, sampling the individuals enacting those roles, interviews for data collection, and content analysis as a primary means of data analysis. Behavioral requirements of a role are gleaned from critical incidents. In this study, critical incidents were examples of VT leader technology facilitation nested in ordinary VT interaction that had a clear impact on how the team used ICT and on team outcomes. Where the term “case” is used below, it refers to critical incidents.

3.2 Sample Context and Selection

The sample for this study was purposeful rather than probability-based, in order to maximize information-rich cases. This is customary in research in which a very specific phenomenon is studied (Patton 1990). Several strategies enable purposeful selection of information-rich cases. This study employed extreme or deviant case sampling. This strategy
targets contexts expected to have plentiful examples of technology facilitation, in order to find examples of technology facilitation that are unusual or special in some way, such as particularly troublesome or successful (Patton 1990). Deviant case sampling provided an ideal fit with the need to find critical incidents.

3.2.1 Technology Facilitation-rich Context

Where could we expect to find plentiful examples of technology facilitation in VTs? One VT typology aided in this regard, it holds that increases in task complexity will accompany increases in the need for VT leaders to “create structures and routines” that handle leadership functions, either through technological substitutes or delegation to other team members (p. 27, Bell et al. 2002). Thus, an appropriate sample context for studying VT leaders and technology facilitation would be one in which task complexity is high. This is the case in virtual IS development projects (Walz et al. 1993; Xia et al. 2004). Work in IS development team projects requires “friction,” meaning that on-going changes and communication are needed to deal with conflicting interpretations during project interaction (Armour 2004). Handling such friction would likely benefit from technology facilitation. Finally, in a technology field, such as IS development, barriers to ICT appropriation will be lower due to increased general familiarity with technology (Edmondson et al. 2000). As a result, we expected that IS development projects would display more ICT flexibility, a condition that would increase the amount of technology facilitation available to observe.

Within VTs there are numerous distinctions that can be made. Which types of IS development VTs would likely have the most technology facilitation? Since those teams facing the most interaction challenges would likely have the greatest need for technology facilitation, existing literature on virtual teams enlightened this selection (Table 5). VTs face greater
interaction challenges the more temporally and geographically dispersed and the more cross-organizational (Griffith et al. 2003; Jarvenpaa et al. 1998; Jarvenpaa et al. 1999; Kimble et al. 2000; Knoll et al. 1998; Maznevski et al. 2000; Montoya-Weiss et al. 2001; Riopelle et al. 2003). Dispersion in terms of time and space increases the number of interaction challenges a VT faces (Benson-Armer et al. 1997; Martins et al. 2004; Powell et al. 2004; Sahay 1998). Work involving multiple organizations also increases the number of interaction challenges faced by the team (Carmel et al. 2002; Jarvenpaa et al. 1999; Kaiser et al. 2004; McFarlan et al. 1995). The more interaction challenges faced by a VT, the more we expected the successful use of ICT would matter. Thus, we sought cases where VTs face maximal interaction challenges. These are IS development VTs engaged in projects with at least two organizations and dispersed across at least two countries or time zones (Table 5).

**Table 5: Interaction Challenges in VTs by Dispersion and Number of Organizations**

<table>
<thead>
<tr>
<th>Dispersion</th>
<th>Temporal</th>
<th>One Time Zone</th>
<th>Organizations Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Few</td>
<td>Mod</td>
</tr>
<tr>
<td>Spatial</td>
<td></td>
<td>Moderate</td>
<td>Maximum *</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>Maximum *</td>
</tr>
<tr>
<td>Geographic</td>
<td>One Location</td>
<td>Few</td>
<td>Mod</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>Moderate</td>
<td>Maximum *</td>
</tr>
<tr>
<td></td>
<td>Locations</td>
<td>Moderate</td>
<td>Maximum *</td>
</tr>
</tbody>
</table>

* VTs ideal for sample in this study.
The availability and character of IS development VT projects provided additional support for their choice as a good sample context. We expected they would be easy to find since the industry has taken to using VTs *en masse* (Chandrasekaran et al. 2004; Sarker et al. 2004; Tiwana et al. 2003). Many of the projects undertaken in IS development involve outsourcing or “cosourcing” (Kaiser et al. 2004) between multiple organizations. Dispersion of members both temporally and geographically also characterize these projects (Malhotra et al. 2004; Nicholson et al. 2004).

In sum, the presence of increased interaction challenges implies a greater potential to see the impact of technology facilitation. Thus, the targeted sampling context was: 1) IS development VTs, 2) engaged in cross-organizational projects, and 3) spanning multiple time-zones or multiple countries.

### 3.2.2 VT Leader Qualification and Recruitment Strategy

We expected that virtual team leaders with experience and a track record of success would have facilitated technology numerous times and would be able to provide the information-rich cases we sought. In order to identify successful VT leaders within industry, we targeted the participation of major IS development firms who have performance measures for their projects and team leaders. Leaders were to be selected from those with moderate to high performance ratings who had led at least one virtual project in the formal role of team leader for at least one year. We were unable to confirm sponsorship of any firms at this higher level. We found that we had to seek the individual leaders directly.
3.2.2.1 Individual Leaders

Once we realized firm-level participation could not be confirmed, leaders were directly contacted and asked to rate their own performance on the Leader Background Form. Such subjective, self-ratings have been found valid, though sometimes inflated, especially the less experience a person has in a job (Fox et al. 1988; Mount et al. 1994). Since the leaders we targeted had to have substantial experience, we expected that their self-ratings would be more accurate. We also collected data about the number projects the leaders had led and the outcomes of those projects in the Leader Background Form and from their résumés, these alternate data sources provided a means to ensure that successful VT leaders were sampled. Through the résumés and other biographical data we found that the leaders were very successful. Seven had been selected for promotion in in-house MBA programs funded by their firms. Eleven of the thirteen (85%) reported being used as “fixers” by their firms. “Fixers” are project managers who are called in when an initial project manager fouls up a project and the firm needs someone to come in and fix the problems. We assumed that a “fixer” would be project manager with high capability and a track record of success. An assumption behind this logic is that low-performing leaders would be moved out of leadership positions and that this pattern would show up in their track record.

It was difficult to determine how much experience a VT leader should have had in order to qualify for this study. The logic we employed follows. One study of three-month student-project VTs provided evidence that perhaps half of the student projects included some technology facilitation, and some included multiple episodes of technology facilitation (Kayworth et al. 2002). At this rate, perhaps three out of five projects would include technology facilitation and one would include two episodes. If so, five projects would yield an average of
four episodes, where an episode refers to an event with technology facilitation critical incidents and its surrounding context. Five projects would equal about 15 months of experience. Our pilot study with current VT leaders indicated that IS development projects in industry come in two main varieties. Some are large and span one or more years. Others are smaller and span 4-8 weeks. Originally, we sought experienced VT leaders based on a number of projects completed; however, this did not seem useful since project length varies so much. Instead, in the period of one year, our pilot studies indicated there would be at least four technology facilitation episodes, the amount we sought from each leader. Thus, interviewees needed at least one year of experience as a VT project leader to qualify for this study.

Finally, ICTs and VT usage were developing rapidly at the time we were conducting the study. We sought leaders with current experience. An individual may not be leading a VT project at the time of the interview, but we needed his or her experience to be current. We set six months as an arbitrary cutoff for experience recency. We figured that VT leaders who had not led an IS development VT project in the six months leading up to the interview would likely not have current information.

In brief, participating leaders had to: 1) self-report successful performance as VT leaders, 2) have at least one year of experience in leading IS development VTs, and 3) have had some IS development VT leading experience within the past six months.

3.2.2.2 Why not include VT members or supervising managers?

Including team members may have led to discovery of a greater range of factors of technology facilitation. Particular to a virtual team and unlike FtF interaction, without physical presence, team members or managers have even less chance to see the complete actions of the VT leader. Thus, VT leaders themselves are the most qualified observers of VT leader behavior.
This narrow use of only the actor perpetrating the role under study is common in CIT studies and has been found adequate to objectively describe the role in question (Andersson et al. 1964; Flanagan 1954). It is one of the reasons CIT fit this study well.

Nonetheless, we attempted to interview at least two members of three VTs from which one of the leaders had reported a critical incident in order to validate our assumptions about members’ ability to know what the leader was doing. This attempt was unsuccessful, but several leaders actually reported cases in which they were members rather than the facilitating leader. As a result, we did capture member viewpoints.

### 3.2.3 Sample Size

Regarding sample size adequacy using CIT, the goal is to collect enough critical incidents so that by the last the likelihood of a new behavior being discovered is in the range of one in fifty (Flanagan 1954). To capture the entirety of a complex job, such as a leader’s, between 2,000 and 4,000 critical incidents would be necessary (Flanagan 1954). For a single activity within a job, 50 to 100 often suffices (Flanagan 1954). Technology facilitation is one of many activities that VT leaders undertake. Its specificity within the broad role of VT leadership led us to believe at least 50 critical incidents would be necessary and sufficient. This seemed especially true when the critical incidents can be collected by interview rather than questionnaire, since a more complete understanding of each incident can be achieved in interviews (Hopkins 1987).

Collecting four or five critical incidents in an interview while also covering background and general questions requires a commitment of approximately two hours (Ellinger et al. 2002). In the pilot interviews, we found that we could expect to cover only four incidents at most in two hours. We expected that VT leaders face time constraints similar to the managers and GSS facilitators previously studied using CIT and would therefore be amenable to a two-hour
interview at the maximum (Kelly et al. 1998). In the hope of getting as many critical incidents as possible from each VT leader, we tried to get four incidents from each, but we recognized that we might only get three. In the end we got three incidents from three interviewees, four from seven, and five from three for a perfect average of four.

In this study we hoped to interview 20 VT leaders for a yield of 80 critical incidents. At this rate, we figured that even if each interview yielded only three incidents and a couple of VT leaders dropped out at the last moment, we would have at least 50- an adequate number for analysis. In the end, we contacted 27 leaders and qualified and interviewed 13 for a yield of 52 complete incidents.

CIT does not require multiple organizations for data sourcing (Flanagan 1954). Since organizational context may conceptually influence the technology facilitation role (Figure 2), we expected sourcing our interviewees from a single organization might introduce unwanted systematic bias. As a result, we ensured that we had VT leaders from a variety of organizations. One very large IT services organization provided housed eight of the interviewees, but they were all from different branches within the organization. We found no systematic bias, and some of the interviewees from the same organization even reported conflicting organizational-level rules, such as one reporting video conferencing as against organizational policy while another said it was up to him to decide.

3.3 Design for Data Collection and Analysis

This study used the Critical Incident Technique (CIT) for data collection and analysis. CIT offers a means to efficiently and empirically explore the VT leader technology facilitation role and the events in which it takes place. It has been used in thousands of studies (Fivars et al.
2001) and has been shown valid and reliable when properly applied (Andersson et al. 1964; Bitner et al. 1985).

CIT was developed by the United States Army Air Forces Aviation Psychology Program during World War II to better understand job effectiveness of pilots. By the mid-50s it had already been employed successfully in scores of studies in several fields (Flanagan 1954). More recently it has been used in fields pertinent to this study including management information systems (Clawson et al. 1993; Hopkins 1987; Kelly et al. 1998) and leadership (Ellinger et al. 2002; Fivars et al. 2001; Yukl 2002). It enables formulation of the critical requirements of a role and is “especially useful in exploratory research designed to examine very specific, situationally relevant aspects of managerial behavior” (Yukl, 2002, p. 57).

3.1 Principles of CIT

Critical Incident Technique consists of systematic procedures for collecting critical incidents of human behavior regarding a specified activity and classifying them in order to facilitate solution of practical problems and to develop broad characterizations about the activity (Flanagan 1954). Per CIT, only simple judgments are required of the interviewee, the interviewees must be qualified to observe the behavior, and all observed behaviors must be judged by the interviewee based on an agreed upon statement of purpose (Flanagan 1954).

CIT, as used in this study, specifically targeted a job role using incidents as a unit of analysis. CIT commonly draws on only one “source”, in this case interviews, using the people who perpetrate the role being studied. Convergence of data in CIT occurs when common themes among incidents and across respondents are found during analysis. The various individuals interviewed are the multiple data sources. In analysis, we did find that the themes crossed
organizational and respondent lines, suggesting to us that the data reflected the role rather than artifacts of sampling bias.

3.3.2 Five Steps for Employing CIT in this Study

3.3.2.1 Step 1: Establish General Aim

Five steps guide the application of CIT (Flanagan 1954). First, the general aim of the specified activity— in this case technology facilitation— to be studied must be established in functional terms, specifying a “brief statement obtained from the authorities in the field which expresses in simple terms those objectives to which most people agree” (Flanagan, 1954, p.336). Based on evidence from the literature and results from the first pilot study (see section 3.6.1), we defined the general aim of VT leader technology facilitation as development of team interaction that enables project progress and, ultimately, improved project outcomes.

3.3.2.2 Step 2: Develop Precise Protocol

The research must create precise instructions. These have four aspects. They must (1) cover the incidents to be collected from the interviewees; (2) explain how these incidents must be relevant to the general aim; (3) explain the extent of effect on the general aim necessary to judge the incidents critical; (4) stipulate who qualifies to be interviewed. First, a critical incident is “extreme behavior, either outstandingly effective or ineffective with respect to attaining the general aims of the activity” (Flanagan 1954). For VT leaders’ technology facilitation, a critical incident was one in which they believe that their attempt to manipulate the team’s technology use led to a distinct change in technology use. Second, the VT leader had to link the change in technology use to improvement or decline in team interaction. Third, the VT leader had to believe that his or her action was the primary cause of the change in technology use and that it

63
led to specific positive or negative project outcomes. Fourth, experienced VT leaders in the IS development industry were qualified. Their qualification is fully described above.

The documents in the appendices were used to collect the data and attend to the data collection issues and some procedural requirements placed by the researcher’s home university. Developing these documents involved two pilot studies and three major revisions. The results of the pilot studies and how they impacted the specific interview questions are reported in sections 3.6.1 and 3.6.2. Briefly, we began in the first pilot study by attempting to survey members and leaders actively engaged in IS development VT projects. We found that there was a lot of volatility and variation in their experiences, and we learned that we needed to conduct interviews to get enough contextual information to understand what was happening with technology facilitation. We also realized we needed to interview VT leaders specifically. The team members did not seem to know very much about what ICT choices were made in their teams.

We developed a first draft of interview guidelines and protocol and piloted them in the second pilot study with an experienced VT leader. Her interview led to numerous changes, some aimed at better clarity, some aimed at ensuring all aspects of the conceptual framework would be covered, and some aimed at ensuring that the interview could be conducted in two hours. The second interview of the second pilot study tested the revised interview protocol, and we found that the protocol worked successfully. A few minor changes were made at this point. In general, during the process of interview question refinement, the protocol got more structured, questions became more specific with optional probing questions added at the interviewer’s discretion, and questions were prioritized to guide the interviewer in case interview time ran short and some questions had to be cut.
3.3.2.3 Step 3: Collect Data

Collect data. This study used interviews, a common method for collecting critical incidents (Flanagan 1954). Collection of critical incidents by interviews requires four conditions be met: (1) that actual technology facilitation behavior is reported; (2) that it was observed by the interviewee; (3) that the given conditions for criticality are met; and (4) that the interviewee has made a definite judgment about the criticality (Flanagan 1954). Additionally, the interviews should be sponsored by the home organization or equivalent authority relative to the interviewees (participants), be clear about why the participants have been chosen for inclusion in the study, and assure anonymity in report of any data they provide (Flanagan 1954).

The steps used in contacting the participants were:

Prospective participants received a packet containing the Introduction and Guidelines for Participants letter (Appendix A), a sheet detailing how to prepare for the interview (Appendix B), a consent form (Appendix D), a guide for describing their projects (Appendix E), and a leader background form (Appendix C). They were also informed of an online version of the Leader Background Form and sent a customized link that would bring them to a guided process that carried them through the questions in the form as an alternative to filling it out by hand. Nine leaders took this option. The online resource also included PDF versions of the documents they received in the packet in case they needed a replacement copy or wanted to access the documents electronically. Several interviewees reported using these files. Interviewees were also allowed to electronically sign the consent form using their own registered digital signature within Adobe Acrobat, if they so desired. Five did this. These efforts at enabling a purely virtual exchange with the leaders was made because of the context of this study and in the expectation that it would fit their own work preferences.
Respondents who sent in their consent and leader background forms filled out were added to the pool of participants, if they met the qualifications. Three respondents were disqualified at this point, and one became a non-responder. It appears, from the information we have on this non-responder, that he did not respond because he was not qualified for the study.

Next, participants prepared for the interview using How to Prepare for the Interview (Appendix B). They were to think through the projects they had led and identify some critical incidents for discussion. Time permitting, they were directed to make notes to aid the interview. If participants did not do this step, we expected the interview would likely require more time spent on them recalling incidents. This time was provided at the interviewer’s discretion in the Researcher’s Interview Guidelines (Appendix F). In such a case, we expected to cover only three incidents in the interview. As mentioned earlier, we were able to cover an average of exactly four incidents per interview; however, the average interview lasted more than two hours (Table 8).

The primary researcher scheduled the interview with each participant and conducted it following the interview guidelines (Appendix F). During the interview, the interviewer began each critical incident by capturing a description of its project context using a Project Context Form (Appendix I). Next, the interviewer asked the Critical Incident Questions about the specific critical incident (Appendix G). If the next critical incident came from a project already covered, the interviewer went directly to the critical incident questions. Otherwise, the interviewer covered a new Project Context Form first. Once all of the projects and critical incidents were covered, the interviewer asked some general questions about the leader’s experiences (Appendix H).
The actual interviews mostly followed the preceding protocol. In at least five interviews the interviewees had not prepared at all. This made sense given how busy the interviewees were. In order to make the interviews work, some exceptions to the protocol were made. Five interviews were conducted in two one-hour blocks. Two were conducted while the interviewees were driving between locations. One took place while the respondent waited in an airport. The latest was scheduled to begin at 10 pm, and the earliest began at 6 am.

The protocol during the interview also required some flexibility. Interviewees were given to mix project and incident data during conversation. In two cases, respondents gave two incidents simultaneously. These had to be separated by the researcher during transcription. In the end, the interviews lasted two hours and ten minutes on average, and four incidents were covered in each.

Following each interview, the researcher transcribed the interview recording and sent an encrypted copy to the interviewee for inspection of accuracy and adequate removal of identifying remarks. The interviewees then read and reviewed their transcripts and sent in any changes they noticed and gave permission to use the data in the final analysis. Five interviewees found changes. These were corrected. Two asked that specific incident data be carefully handled and never published except in summary form. The remaining interviewees accepted the transcriptions as they were. The researcher read through the transcripts one more time to make sure there were no additional compromises of anonymity and made necessary changes where issues were found. For example, all names of individuals and companies were changed to protect the interviewees from being identified. This step helped ensure validity of the data and confidentiality for the interviewee. The interviewer contacted the respondents for clarification where questions arose during transcription. This happened in five cases.
This process had been tested fully in the second pilot interview and found to work well. Overall, it worked well in the main study too. In all, 52 incidents of technology facilitation were collected from 30 projects reported by 13 qualified interviewees (Table 8, Table 9, and Table 11). These will be discussed in Chapter 4.

3.3.2.4 Aggregate and Analyze Data

Fourth, data are aggregated and analyzed. According to Flanagan, two primary problems in analysis are: (1) the selection of a general frame of reference to describe the incidents (guided by the intended use of the findings), (2) the inductive development of categories (pp. 344-345, Flanagan 1954).

We developed a general frame to describe the incidents from the conceptual model based on AST (Figure 2). Prior CIT studies of GSS facilitators and of learning organization managers guided this development by offering categories for parsing the incident process into triggers, behaviors, outcomes, and beliefs (Ellinger 1997; Kelly et al. 1998). Due to the importance of separating structural changes from the impact on work in AST research, we split the outcomes category into structural changes and team outcomes. Per AST, the triggers are structural, and the behaviors in this study were leader actions, so those categories were relabeled. This resulted in Figure 3. Four time points lead from the initial state through the impact on work, and the beliefs are considered as expressions of the leaders’ mental models and therefore stable over the period of an incident.
The inductive development of categories involved coding and content analysis within the five root categorizations identified in the general frame of reference for describing the critical incidents. Since this process was very involved, it is described separately in section 3.4 below.

3.3.2.5 Step 5: Interpret Data and Report the Data

Interpret and report. In this last step, the judgments made in collecting and analyzing the data must be carefully reviewed. The researcher(s) must pay attention to two subjective factors—the classification of critical incidents and inferences for practical procedures to improve performance based on the critical incidents—that can introduce bias and address how they have been handled (Flanagan 1954). By including multiple coders and inter-rater consensus as well as review of the findings by study participants this study addressed the subjective factors. The next section details the coding and content analysis process. The analysis and interpretation are explained in chapter 4 and 5, respectively.
3.4 Coding and Content Analysis

CIT analysis employs content analysis to draw the schema out of the data (Hunt 1991). Content analysis requires the researcher to “[take] the communications that people have produced and [ask] questions of the communications” (Kerlinger 1986). Its basic units of analysis are words, themes, characters, items, and space-time measures. Coding is the primary mechanism for separating and making sense out of data in content analysis (Neuendorf 2002). The critical incidents data were coded in three stages. Each is detailed below in its own subsection.

3.4.1 Stage 1: Splitting Data into the Root Categorizations

While deciding which categories to define was fairly simple and could follow the example set in previous research, defining these categories in reliable, codable terms that would communicate their essence easily and explicitly to others proved more complex. This process is the first step in developing the codebook (Boyatzis 1998). The researcher wrote an initial codebook with definitions, indicators, and examples, made a training video for this codebook, and selected initial coders with expertise in empirical research in the MIS field.

Developing the codebook took three rounds of refinement. In the first round, the primary researcher randomly selected five incidents, representing slightly more than 10% of the total critical incident transcript text as a sample for judging inter-rater reliability (IRR) plus one additional incident as an incident for training coders. This process for establishing coding validity is particularly suited to critical incidents research involving interviews and coding (Boyatzis 1998). Two initial coding rounds in this stage involved two and two coders, respectively, as well as a preliminary round of expert opinion on the codebook phrasing, given
by two researchers with knowledge in this study’s domain. These checks led to several revisions of the phrasing of the final codebook (Appendix J).

Developing the root categorization definitions into a codebook was followed by reading the complete transcribed text, identifying leader statements pertinent to the root categorizations, and formally associating them with each other in coding software. After two rounds of revision, two coders who had not yet participated were trained and coded the IRR sample using the refined codebook. The primary researcher also recoded all of the transcripts. We calculated agreement on presence of codes as outlined in Boyatzis for critical incident data coding reliability measurement (Boyatzis 1998). Coder one had 72.3% agreement with the primary researcher, and coder two had 72.7%. These levels are adequate for exploratory research of this nature (Boyatzis 1998), providing confidence that we had consistency in the judgments made to link the conceptual definitions to the coded data (Yin 2003).

3.4.2 Stage 2: Identifying and Validating Theme Codes

We had planned to conduct the coding in only two stages, but in piloting the final stage, we discovered that the magnitude of the data required another stage of refinement be added to summarize and condense the content of the 1,960 quotations found in the first stage. This added second stage of coding involved the primary researcher reviewing all of the selected 1,960 quotations that had been coded as triggers, actions, structural changes, team outcomes, or beliefs and determining a short summary theme code for each. The goal of each theme code was to capture the essence of a quotation from the transcript in a short form that would immediately convey its meaning in a minimum number of words. Where one quotation seemed to share one or more theme codes with a preceding quotation, the same theme code was reused. Thus, for example, four quotations which all discussed finding a reason for a problem could be represented
by one theme code. For example, one of the action theme codes is “confront unacceptable use.” It is related to three action quotations from the transcripts. This theme code and its quotations are shown in Appendix M.

In this process, the coding software, Atlas.Ti 5 was very helpful. It allowed the codes and their associated quotes to be extracted into individual documents focused on the five rot categorizations of the general frame. The quotations could then be analyzed next to all of the other associated quotations with more than 90% of the transcript text screened out as unimportant noise. This enabled the identification of theme codes within each of the five general frame categories. Those theme codes were automatically stored in a palette from which they could easily be accessed. Where a theme repeated, multiple quotations were assigned to a theme code as mentioned above. To check the validity of these judgments, a senior, outside researcher with an extensive background in human subjects, empirical research was brought in to to a code-quotes analysis. This codes-quotes analysis involved him reading the complete initial set of 432 theme codes along with the quotations assigned to them and marking any code that was either phrased inappropriately or any quotation that did not seem applicable to a code with which it was associated. He also commented on the need to split a code into multiple themes or merge multiple codes where he felt this appropriate (see Appendix M for a sample of the Codes-Quotes lists used in this process).
Table 6: Initial and Final Theme Code Counts

<table>
<thead>
<tr>
<th>Trigger</th>
<th>Action</th>
<th>Change</th>
<th>Outcome</th>
<th>Belief</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>73</td>
<td>69</td>
<td>53</td>
<td>102</td>
<td>135</td>
</tr>
<tr>
<td>Final</td>
<td>82</td>
<td>69</td>
<td>52</td>
<td>101</td>
<td>135</td>
</tr>
</tbody>
</table>

The reviewer in this round served two main functions. He looked at the phrasing of the theme codes and suggested more than 40 revisions to improve clarity, and he checked to ensure that the theme codes represented the quotations assigned to them. In three cases, he recommended that the codes be rephrased altogether, and in five cases he recommended that the codes be split into multiple codes. The primary researcher talked through each of the theme codes with the outside researcher and they reached a consensus on all of the suggested changes, developing an agreement on what to do where there was no clear opinion. This process has been used in similar studies (Ellinger et al. 2002; Kelly et al. 1998) to help ensure validity of interpretation (Yin 2003).

The process of splitting codes was achieved by sorting out the quotations assigned to specific theme codes. For example, one code entitled “organization / culture “ was divided into five theme codes. For splitting, discussion ensued to identify the target themes. Screen shots of this splitting process are shown in Appendix L. In two cases, theme codes were judged identical and merged. At the end of this round final lists of theme codes emerged for triggers (Appendix N), actions (Appendix O), structural changes (Appendix P), team outcomes (Appendix Q), and mental model beliefs (Appendix R).
3.4.3 Stage 3: Identifying Major and Minor Themes

The goal of the third coding round was to identify major and minor themes among the five categories of codes produced in stages one and two and define them by consensus of multiple judges with independent opinions. The major themes became the dimensions of the root categorizations and directly constitute five of the deliverables in this study.

Each theme code was printed onto its own two by three inch card along with an arbitrarily assigned unique identification number. The five general frame categories were kept separate by labeling the category in small print on each card and by printing each category of cards on its own color of paper. A new set of instructions was drawn up following a sorting process used in prior, similar studies (Ellinger et al. 2002; Kelly et al. 1998). Basically, the sorting involved the researcher or another judge spreading the theme code cards for a given root category on a large table, shuffling them, and then reading through them and placing them in stacks that went together according to the sorter’s opinion.

The instructions for sorting were piloted one full round with the primary researcher and an outside researcher who had not yet participated in the study. Following this pilot they were revised, producing Appendix S. The primary researcher then followed these instructions for each root category, sorting the theme codes into major themes and minor themes and recording the result. Three additional judges participated in this sorting stage. One had not been involved in the research at all up to this point and had extensive background in qualitative research and content analysis. Another had been involved in stage two as the outside expert. A third had extensive background and involvement in the research project. This variety of judges, two inside the project and two external with one senior and one junior in each pair, was sought to help
ensure independence of judgment and useful variety in the discovery of novel information in the content analysis (Neuendorf 2002).

The primary researcher attended each sorting and recorded the sorters’ results having discovered in two pilot sortings that using the Sorting Record Sheet was difficult for sorters, especially for depicting the hierarchical or multi-dimensional relationships they were finding (Appendix T). The primary researcher then gathered the collected sortings of major and minor themes identified by these sorters into a custom database. Getting the data from Atlas.Ti 5 proved difficult. It had to be exported as XML, displayed in a browser using a custom XSL style, pasted into a Microsoft Excel spreadsheet, and then imported into Microsoft Access. This Access database was designed to handle all of the relationships and searches that would be needed during analysis. It proved critical. While the Atlas.Ti 5 software had been useful during the first two rounds, it did not provide adequate data manipulation tools in the primary researcher’s judgment for this round. The database schema is shown in Appendix V. Reports showing the complete sorting data were developed for each sorting. One such report is reproduced in Appendix T, including the original hand-written capture of the sorting data.

One Sunday, three of the round three sorters met and discussed each set of reports, for the Triggers, Actions, Changes, and Outcomes. Their role was transformed to that of judges for the purpose of achieving consensus of interpretation of the sorted categories. The Beliefs were left out at this point so that the focus could be put on the triggers, actions, structural changes, and outcomes without distraction from the general opinions represented in the beliefs. The Beliefs were later run through a similar process involving the primary researcher and one of the sorters. The Beliefs process was modified since the Beliefs largely corresponded to a single statement by
a single interviewee in one interview. As a result, the Beliefs are not reported with the levels of agreement or frequency counts that accompany the other four categories.

By the end of the meeting that Sunday, all had reached consensus on major and minor dimensions of the four critical incident categories. Consensus was achieved by methodically going through each set of reports and discussing the major themes that the judges found consistent across each. Where disagreement occurred, the judges carefully examined the theme codes within the groupings being considered to see how many agreed in the different groupings produced in the different judges’ reports. Where there was high agreement between the theme codes making up groups, the judges allowed the creation of a major or minor theme. In one case, the accountability major theme within the outcome category, the amount of agreement was low but the judges all felt this was an important outcome that each judge had found in some form, and the accountability category was kept by consensus. The resulting major and minor themes are presented in Chapter 4. In all, at least nine individuals contributed more than a total of 68 hours of work to the three rounds of coding and sorting in addition to the countless hours spent by the primary researcher.

3.5 Developing the Final Dimension Lists

In order to convert the transcribed critical incident data into the deliverables that answer the research questions, we undertook the data collection and coding process described above. At the end of this process, we had a database populated with 439 relevant codes, their five root categorizations, their relationships to each other and the interviews, groupings of the codes by categorization by four independent judges, and final groupings of the codes arrived at by consensus of the judges on what were the key dimensions of each root categorization.
The final, consensus dimensions were captured in the custom-built code database so that the number of judges who had independently arrived at the same dimension was tracked and the number of discrete interviews and incidents from which a code derived could be traced. From the data on the original groupings formed independently by the judges, we were able to trace the levels of agreement for each code within each dimension. These levels ranged from 1 to 4 depending on how many judges had originally placed a given code in a given dimension prior to the consensus process. They were printed on reports and inspected to see that each dimension had at least some theme codes with high independent agreement among the judges. All theme codes had the consensus of the judges. So, the levels of agreement were considered simply an extra step to check for agreement. In all but one dimension, the levels were very high. In the one low dimension, client satisfaction, the judges determined the dimension should be kept when they discussed it.

Next, we gathered the number of discrete interviews and incidents in which each code was identified. We developed two initial statistics as alternatives to quotation counts which are often used to show the level of external validity or prevalence of an item in content analysis (Muhr et al. 2004; Neuendorf 2002). The number of interviews from which a code derived helped identify how pervasive the phenomenon it represents is in the virtual team IT project world. The number of incidents did the same but provided a correction in case particular codes were represented in multiple incidents within the same interview. The quotation count can get at this prevalence too, but the quotation count may be inflated with bias if a given interviewee happens to talk about the same given phenomenon more than once within a specific critical incident. In such a case, the code may appear twice or more in the incident transcript but refer to
the same observation, giving the impression that the phenomenon occurred multiple times though it did not.

Finally, we wanted a means for understanding the combined prevalence of each theme code in the transcript data. We created a weight statistic to do this. Individually, the interview and incident counts for each theme code provided a measure of how much the theme appeared in the data. We used these statistics in the analysis process but sought to create a joint statistic to see if it might help yield some insight into overall prevalence. This weight was conceived as a combination between the number of incidents and interviews associated with each theme code and dimension. The formula for the weight was:

\[
\frac{\alpha}{13} + \frac{\alpha}{13} + \frac{\beta}{52} \times 100
\]

Alpha represents the number of discrete interviews in which a theme code or dimension was present. Beta represents the number of discrete incidents in which a theme code or dimension was present. There were a total of 13 interviews and 52 incidents. So, the formula represents the ratio of interviews weighted twice and added to the ratio of incidents for a given theme code or dimension and then divided by three and multiplied by 100 to produce a final weight. The range of this weight is 5.77 for codes appearing in only one incident and one interview to 100 for codes appearing in all incidents and interviews. In creating the weight we considered that the incident ratio alone might be inflated if a given interviewee has a particular issue s/he constantly addresses, causing a code to show up in all of his or her incidents. Likewise, each interviewee might have one incident that has a given code, but that would be much less prevalent than if 40 or 50 incidents have a given code. Thus, we needed to combine the two. However, they did not seem equivalent. Having a higher ratio of interviews would
indicate broader prevalence in the world of VT projects than having a higher ratio of incidents. So, we arbitrarily weighted the interview ratio twice to increase its influence in the weight. Finally, we multiplied by 100 to derive a weight for each theme code and dimension. The theme codes were then ordered by this weight in the tables in chapter 4.

The last step in preparing the data for analysis involved the primary researcher culling duplicate codes from the major theme dimensions. Since four judges’ individual categorizations were merged in order to create the final dimensions, there were some theme codes that ended up in multiple dimensions. Theoretically, this resembles the result of a factor analysis where items load on multiple factors but must be assigned to one factor or another. In this analysis some items logically fit into multiple categories. For example, one judge had a category named “Culture.” Another had two categories, “Organizational Culture” and “International Culture.” In merging these categories, all of the codes under the first judge’s “Culture” category were associated with both of the second judge’s categories. The primary researcher went through the categories and decided a single, best-fit category to contain each theme code where codes ended up placed in more than one category. The numbers of codes originally associated with the entire pool of categories for each of the first four root categorizations and the number culled are reported in Table 7 below. Where the word “tool” is reported in the tables and discussion below it refers to an information and communication technology (ICT).
Table 7: Culling of Duplicate Codes to Produce Final Dimensions

<table>
<thead>
<tr>
<th>Focus of Investigation Element</th>
<th>Triggers</th>
<th>Actions</th>
<th>Changes</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Number of Codes</td>
<td>79</td>
<td>125</td>
<td>71</td>
<td>169</td>
</tr>
<tr>
<td>Number of Codes Culled</td>
<td>14</td>
<td>58</td>
<td>24</td>
<td>64</td>
</tr>
</tbody>
</table>

The beliefs theme codes required some separate attention, because of their idiosyncratic nature. They represent a one-to-one correspondence between leader quotations and theme codes. Thus, the beliefs theme codes are often simplifications of specific statements in the transcript text rather than representative of themes that cross multiple interviews or incidents. With this in mind, frequency counts for incidents and interviews were not as useful, even though we reported them.

Also, the beliefs overlapped quite a bit, such that different judges’ categories included the same theme codes under different dimension though the judges agreed the theme code should be in both dimensions. The judges agreed there were several ways to see a number of the beliefs in terms of major and minor themes. One overlapping major theme, technology contingencies, was retained because the judges and the primary researcher found them relevant. It contains numerous theme codes that are also listed under beliefs about specific ICTs.
3.6 Pilot Studies

Two pilot studies were conducted in the process of designing this research. The first examined the virtual team context and determined that it can be sampled and that technology facilitation is an important issue in practice. The second pilot study honed the interview methodology for the main data collection.

3.6.1 First Pilot Study

An initial pilot survey of virtual team leaders and members in a global IT services company with revenues of $90 billion per year was conducted in April 2004. Designed to function primarily as a probing device, this early pilot study helped explore whether to use a survey or interview data collection in the Critical Incidents Technique. It also provided feedback about the context of technology facilitation and existence and importance of the phenomenon in practice.

Participants were asked to describe their own experience with virtual teams, whether they have been a leader and what leadership arrangements they perceive most common. A second set of questions focused on critical success factors for VT high performance or success. These began general and narrowed to technology and then the leader role in order to avoid guiding the respondents too much initially. A third question set asked them to list technologies they use in VTs and mark the level of importance and why the technologies are used.

The survey sample was taken by convenience from participants in an executive MBA program at a large, public university located in the southeastern United States. Most participants had extensive industry experience—49% of their total work time in the past two years—working on virtual teams, and their job functions covered a wide range of IT services. Twenty-one of 25
individuals completed the survey. These rough results indicated that the majority (60%) of VTs in this company have a single, formal leader. Another portion (32%) had multiple, formal leaders.

One surprising finding was that the leaders reported the same ICT being used to fill different team interaction needs even within this small sample. For example, email was used for file transfer in one person’s experience while another used it for discussion. This variance in possible core uses of a given ICT suggests the importance of context in assessing ICT impact on team interaction. As technology facilitation deals primarily with using ICT to affect team interaction, this early pilot study supported the choice to explore technology facilitation in the field with data from actual team projects, and this further supports the choice of using interviews for data collection.

Fourteen of the participants had experience as VT leaders. Seven participants who had been VT leaders suggested the importance of facilitating their teams’ technology usage as a critical success factor. Specific suggestions included setting expectations of tool use including standards for communication, physically providing and managing the ICTs through “tool selection and enablement,” ensuring access for each team member to timely, necessary information, and handling any issues as they arise. Responses from the other seven focused more on the need to ensure progress, a potential outcome of technology facilitation. As responses to a question on the “VT leader’s role in critical success factors” for VT “high-performance or success” these suggestions support the importance of studying the VT leader’s role as a technology facilitator. Above all, the respondents stressed the importance of the VT leader enabling project progress.
The data pointed to the importance and complexity of the VT leader role, because of the many critical functions of VT leaders noted by survey participants. Based on this finding, interviews were decided on as a data collection method in the main study due to their ability to capture richer data and better handle complex and poorly understood phenomena.

3.6.2 Second Pilot Study

In September 2004, a second pilot study was conducted to test the interview protocol and questions and determine if any additional changes would be necessary. Two VT leaders with at least one year of experience leading a VT in the IS development industry were interviewed. The first had 13 months of experience and was interviewed F2F. The second had more than twelve years of experience and was interviewed by telephone. Changes based on lessons from this pilot study were made following the F2F interview and again following the telephone interview. The lessons are listed below by interview. While there were numerous changes consequent to the first interview, few changes followed the second. This led to the judgment that the protocol is ready for use in the main study.

One additional point came out of these pilot studies. It became clear that leaders almost never occupy a role as the single, formal leader. They exist in management hierarchies with superior and, often, subordinate leaders. From a project standpoint, there will likely be differences between the overall project leader and the subordinate leaders in terms of power and authority. As the first pilot interviewee indicated, she was told to technology facilitate. Further, the role a leader plays can vary from project to project, as was clear in the second pilot interview. Since power is a concern in this study, it will likely be helpful if the VT leaders we interview have experience as the overall project leader, but we must recognize that the real environment is varied and critical incidents recalled by leaders may involve multiple contexts in terms of
leadership structure. Thus, we added a more detailed question on the formal leader role in the Project Context Form to help control for any influences wrought by leadership structure in a given critical incident.

3.6.2.1 Lessons from First Interview

The following points emerged from the first interview:

1) [timing] It took one hour and 50 minutes to cover four incidents and the other questions including some issues with the Leader Background Form. Ten additional minutes were spent getting situated. There was only one project. If there were more projects, it would not have been possible to cover even four incidents. Some questions seemed redundant, especially since there was only one project under discussion. Removing these redundancies could free up time to cover more projects, an additional incident, or go into more depth as needed. As a result, the Project Description Guide was developed to enable faster covering of project context. Several questions were removed. Two were reworded with more discrete answers that would be quicker to answer, and questions were judged on two levels of necessity. Lower-necessity questions were marked “skippable” to indicate that they could be left out in order to cover more incidents in case of a shortage of time in an interview.

2) [accuracy] A couple of the questions were misunderstood on the leader form and in the critical incident questions. Some misunderstandings were easily handled during the interview, but a couple questions remained unclear. These were reworded.

3) [leader background] The leader's position within the project hierarchy and organization became important. Previously, there was no question isolating this data. The leader may be at any of multiple levels. In this case, the leader was a low-level leader of a technical
team. She was under three other levels of leaders who were often handing down the command to structure, thus triggering technology facilitation. A question was added that captured this data.

4) [variation] Almost all of the questions seemed relevant except for a few redundancies. The interviewee thanked the interviewer and said she learned about her own experiences through the interview process. This provides some evidence of the design’s utility to practice. The mental model questions were hard to get answered directly but were partially answered elsewhere in response to other questions. There was some variation in the actions the leader took, but actual actions taken were not adequately captured. The mental model questions and leader action questions were reworded to better evoke the phenomenon.

5) [overall] This first interview went well. The protocol worked for the most part. The recording equipment (an iPod with iTalk adapter) worked fine from across the room. The need for active ICT management (technology facilitation) was confirmed by the leader's answers to structured questions and personal testimony to its importance at the end of the interview.

3.6.2.2 Lessons from the Second Interview

1) [timing] The timing issues were corrected. In one hour and 58 minutes four critical incidents, three projects, the leader background form and the general questions were all covered without rushing. A few of the skippable questions were skipped, especially in cases where the information had been given in response to other questions. The Project Context Form and Project Description Guide worked together well, decreasing the time to cover one project from about 20 minutes to 10 minutes while improving the accuracy of the answers. The interviewee liked having the guide and mentioned that the structured interview’s flow seemed comfortable.
2)  [accuracy] The questions evoked accurate responses for the most part. In analyzing the transcript, several opportunities for clarification were identified. On inspection of the written items in the forms, three questions were re-written and six questions gained sub-items to ensure adequate detail and replicability. Additionally, one sub-item was converted to an optional probe question. These changes were considered minor.

3)  [overall] This second interview went very well. The protocol worked. The recording equipment (an iPod with telephone recording adapter) worked fine. The need for active ICT management (technology facilitation) was confirmed by the leader's answers to structured questions and personal testimony to its importance at the end of the interview. The protocol was judged ready for the main study, and the answers in this second interview were judged usable in the final analysis due to a lack of major changes to the protocol.

3.7 Summary

This study’s intensity sample strategy aimed to maximize the presence and effects of technology facilitation. Per intensity sampling, we agreed that participating leaders would need to be experienced and successful. Each participant had to have at least one year of virtual team leadership experience, self-reported success, as well as, observable measures of success, such as evidence of promotion, titles, or awards for their work as virtual team leaders. We qualified thirteen leaders for the study out of more than twenty contacted. Their virtual team experience drew from a variety of firms conducting information systems development projects, including many top-rated IT outsourcing vendors (McDougall 2005). We targeted incidents with maximum interaction challenges, conceptualized as high dispersion and members from multiple organizations. Forty-four of the 52 incidents found had maximum interaction challenges.
We interviewed the leaders and collected some tabulated background data from them. The median interview length was two hours and ten minutes (Table 8). The shortest was one hour and fifty-five minutes, the longest two hours and fifty-six minutes. In order to maximize the information gathered, each interview followed the structured critical incident technique process outlined above.

We delineated this process to the leaders in advance in an introductory packet including a guide document with preparatory questions and an agenda (see Appendices A, B, C, D, and E). Roughly a quarter of each interview focused on collecting data on the projects being discussed. Fifty percent focused on discussing critical incidents when the leader facilitated technology use in the team, and the last quarter focused on general questions about the leader’s technology facilitation, virtual teaming, and ICT beliefs.

In the interviews we captured fifty-two critical incidents of technology facilitation. The researcher transcribed these interviews himself, making notes as he transcribed. He had also made exit notes following each interview to record any impressions or lingering questions that occurred to him. The transcribed incidents fill 510 pages. Transcript drafts were encrypted as PDF files and sent to the interviewees for review. Each interviewee received a non-trivial password to open their transcript draft. These were sent by a separate communication to ensure data security and participant anonymity.

It seemed, to the researcher, that the data collection, framing, and transcription were the largest pieces of work in this dissertation and that data analysis would be fairly straight-forward and simple. Doing a good job analyzing qualitative data turned out much more involved than expected. What was expected to be a two-step coding process was drawn out into three steps to ensure better validity. The first step was performed three times. And each coding step had
multiple coders both during development and different multiple coders during the final analysis phase. The coders were selected on two criteria. Some had expertise at qualitative data analysis, and some had expertise in the information systems field. Two had both. In the first and third steps one of each of these coders was used to check for biases. Ultimately, nine people contributed a combined sum of more than 68 hours of labor during the three rounds of coding in addition to the researcher’s many weeks’ work.
CHAPTER 4: DATA ANALYSIS

4.0 Chapter Overview

This chapter presents the findings of this study. It begins with descriptive data on the individual VT leaders interviewed, the projects they reported, the ICTs they reported using, and the specific critical incidents found. The following sections present the main deliverables of this study, categorizations of the triggers, actions, changes, outcomes, and beliefs pertaining to technology facilitation. These five sections include detailed analysis tables that list all of the codes associated with the various categorizations as well as measurements of the relative prevalence of the codes and categorizations in the data. Where appropriate, additional tables and discussion are added to analyze issues raised in Chapter 2, such as how project stages relate to leader actions and what sorts of structural changes are occurring. The final section presents an ad hoc analysis of the interactive relationships between people, technology, and task structures found.

4.1 Description of Virtual Team Leaders Interviewed

The virtual team leaders exemplified the criteria we sought. They were experienced, successful, and currently involved in virtual teamwork (Table 8). Their median level of self-reported success as virtual team leaders was 8 on a 10-point scale. Only one reported self-success as moderate, and we had theoretically required them all to report medium to high success in order to qualify. The one who reported medium success (6 out of 10) had objective measures of success, such as his promotion to a Director level position in a major consulting firm in which
he oversees other virtual team leaders. Other objective success measures included eight in senior-level positions in their firms, and seven chosen for advancement in firm-sponsored Master’s degree programs. A final measure of sampling success that emerged in the interviews was self-report as being a “fixer.” “Fixers” are project leaders who are reserved as back-ups and called in to fix things when a project has problems. Eleven interviewees reported being “fixers” or having been the person their firm called in when a project was not going well and needed to be fixed.

They reported experience working for more than 20 firms in all, including six of the firms Information Week recently ranked as top IT outsourcing firms (McDougall 2005). In these firms they had collectively completed 55 virtual team projects over 65 years of virtual team leadership experience (median 4 years, standard deviation 3.34 years) and 130 years of team leadership experience in business (median 8 years, standard deviation 8.12 years). The total amount of interview time with the participants was 29 hours and 46 minutes.

The interviewees represented a range of demographics as well. Ten were citizens of the US, and three were from other countries. Eleven were male, and two were female. Three had a background of working in both the technical- programming and systems development sorts of areas- and business- sales and product development sorts of areas- aspects of their industry. Six came from predominantly a technical background, and the remaining four had a predominantly business focus.
Table 8: Interviewee Summary Data

<table>
<thead>
<tr>
<th>ID</th>
<th>Industry</th>
<th>VT Leadership Experience (years)</th>
<th>Number of VT Projects Led</th>
<th>Non-VT Leadership Experience (years)</th>
<th>Average Project Duration (months)*</th>
<th>Self-reported Success (out of 10)</th>
<th>Interview Duration (hh:mm)</th>
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<td>2</td>
<td>15</td>
<td>12</td>
<td>6</td>
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</tr>
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</tr>
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<td>2</td>
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<td>9</td>
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<td>4</td>
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<td>Marketing</td>
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<td>3</td>
<td>4</td>
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</tr>
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<td>Number of VT Projects Led</td>
<td>Non-VT Leadership Experience (years)</td>
<td>Average Project Duration (months)*</td>
<td>Self-reported Success (out of 10)</td>
<td>Interview Duration (hh:mm)</td>
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Average: 5.00 4.23 10.00 8.50 7.92 2:17  
Median: 4.00 4.00 8.00 9.00 8.00 2:10  
Standard Deviation: 3.34 1.30 8.12 4.38 1.26 0:20  
Maximum: 12 6 34 18 9 2:56  
Minimum: 2 1 2 1.5 5 1:55  

* Some interviewees reported duration of stages or phases of longer, multi-year projects.
4.2 Description of Projects Found

The 30 projects encountered were large with a median monthly budget of approximately $625,000 (Table 9). Several interviewees could only estimate these budget figures. In many cases, they only knew the portion of the budget under their control. This seemed especially true in projects involving multiple firms and outsourcing arrangements. With a large budget comes a large team membership. The projects had reported team memberships as large as 300 members in four cases. If one takes a rule of thumb from the small group research literature, a group of more than seven members is large (Hare et al. 1994). The leaders had to estimate the average number of team members, because they reported substantial fluctuation in the memberships of their teams over the life of their projects. In some cases leaders reported only the number of people in their immediate workgroup. In other cases, they reported the overall team membership. In the cases where we could identify the immediate workgroup, it ranged from 5 to 40 members. Only 6 of the 30 projects had “small” immediate workgroups of fewer than 10 members.

Within these large projects, the time spans varied. Virtual team projects seemed to come in two predominant varieties. There seemed to be two- to six-month projects and one- to five-year projects. We had asked only how long the average virtual team project lasted, and several leaders had trouble with this question, noting that there were different classes of project based on duration.

The types of work encountered or domain within the information technology (IT) industry seemed fully represented. Eleven projects (37% of the projects) involved the development of new software systems. Six (20%) involved implementing large software packages, five (17%) of which were enterprise resource planning (ERP) systems. Another six
(20%) involved broad change initiatives involving IT business process re-engineering (BPR), sometimes in legacy systems as well as new system development, along with change management or restructuring initiatives that went beyond IT. Another subgroup included five (17%) projects that simply analyzed an IT initiative, producing system documentation or rationale. Two projects did not fit into categories. One involved a large outsourcing initiative in which all of the in-house IT at a large firm was outsourced. While some of the other projects involved subgroups who were contract outsourcers, we classify this project in a different group because it was a permanent organizational change in the IT function. The last project dealt with patching thousands of customized business systems in order to handle Y2K bugs.
<table>
<thead>
<tr>
<th>ID</th>
<th>IT Domain</th>
<th>Project</th>
<th>Months</th>
<th>Budget</th>
<th>Team size (members)</th>
<th>Number of Organizations</th>
<th>Leader Position *</th>
<th>Formal Orientation?</th>
<th>Number of Incidents</th>
<th>Number of ICTs Used</th>
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<td>Analysis/Assessment</td>
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<td>12</td>
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<td>2</td>
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<td>I35P3</td>
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<td>Health Compliance</td>
<td>36</td>
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<td>160</td>
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<td>Project</td>
<td>Months</td>
<td>Budget</td>
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<td>Formal Orientation?</td>
<td>Number of Incidents</td>
<td>Number of ICTs Used</td>
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<td>HR System Reengineering</td>
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<td>20</td>
<td>3</td>
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<td>BPR/ Legacy Upgrade</td>
<td>Marketing System Overhaul</td>
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<td>BPR/ Legacy Upgrade</td>
<td>Upgrade for Legal Compliance</td>
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<td>6</td>
<td>3</td>
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<td>No</td>
<td>2</td>
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<td>Implementation</td>
<td>Energy ERP Implementation</td>
<td>12</td>
<td>$14,000,000</td>
<td>25</td>
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<td>1</td>
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<td>Global ERP Implementation</td>
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<td>300</td>
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<td>3</td>
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<td>Budget</td>
<td>Team size (members)</td>
<td>Number of Organizations</td>
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<td>Number of ICTs Used</td>
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<td>Spr. ERP Implementation</td>
<td>3</td>
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<td>12</td>
<td>4</td>
<td>High</td>
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<td>Data Management System</td>
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<td>13</td>
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<td>Data Pipeline System</td>
<td>29</td>
<td>$1,300,000</td>
<td>5</td>
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<td>High</td>
<td>Yes</td>
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<tr>
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<td>Demand Forecasting System</td>
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<td>$4,000,000</td>
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<td>File System Next Release</td>
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<td>Portal Development</td>
<td>12</td>
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<td>60</td>
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<td>I34P3</td>
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<td>Web E-Commerce System</td>
<td>8.5</td>
<td>$5,000,000</td>
<td>40</td>
<td>6</td>
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<td>1</td>
<td>14</td>
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<tr>
<td>ID</td>
<td>IT Domain</td>
<td>Project</td>
<td>Months</td>
<td>Budget</td>
<td>Team size (members)</td>
<td>Number of Organizations</td>
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<td>Number of ICTs Used</td>
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<tr>
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<tr>
<td>I26P2</td>
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<td>Web-Back Office Integration</td>
<td>8</td>
<td>$4,000,000</td>
<td>6</td>
<td>2</td>
<td>Top</td>
<td>Yes</td>
<td>2</td>
<td>9</td>
</tr>
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<td>I34P3</td>
<td>New System</td>
<td>Workflow System</td>
<td>6</td>
<td>$500,000</td>
<td>20</td>
<td>2</td>
<td>Top</td>
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<td>1</td>
<td>14</td>
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<tr>
<td>I34P2</td>
<td>Other: Patching</td>
<td>Y2K Systems Correction Factory</td>
<td>12</td>
<td>$10,000,000</td>
<td>135</td>
<td>3</td>
<td>High</td>
<td>Yes</td>
<td>1</td>
<td>15</td>
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<tr>
<td>I35P1</td>
<td>Other: Outsourcing</td>
<td>Legacy Systems Outsourcing</td>
<td>12</td>
<td>$45,000,000</td>
<td>95</td>
<td>2</td>
<td>High</td>
<td>Yes</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

| Median | 12 | $7,500,000 | 30 | 4 | T = 14 | 20 | 12.5 |
| Low    | 1  | $50,000   | 5  | 1 | H = 13 | 10 | 7    |
| High   | 60 | $55,000,000| 300| 60| L = 3  |    | 18   |

Median Budget / Month: $625,000
* This column reports the leader’s position in the leadership hierarchy for the project. One of the pilot studies for this study showed that leaders had multiple roles, depending on the project. Thus, one leader may be the top project manager in one project, a high or top-tier leader (interacting directly with the top leader) in the next, or a low or lower-tier leader in another.
The projects were more volatile than we expected. For example, we expected that projects would retain approximately the same number of team members over their lifespan based on our review of 86 virtual team articles. We were surprised to find that team membership sizes fluctuated in most of the projects. Size would often begin small (5-12 members) during an early project phase, expanding to perhaps 60 members and five organizations during development and end with a new group added for implementation. Some projects also experienced unexpected fluctuations due to hiring mid-project when difficulties were encountered and additional human resources had to be acquired or fired.

Volatility also came through in the nature of the team member commitment. In 14 (47%) projects, team leaders were expected to be both production-line workers as well as team leaders. A fifth of the projects had 20% or more of the members constantly traveling, a category of team member we had not encountered in the literature review. In 17 of the 30 (57%) projects team members were assigned to other projects simultaneously and had to split their time between the competing commitments.

Time pressure was another theme. Each project was characterized by time pressure to deliver. Leaders made statements like, “The clock was ticking down to Dec 31st 1999, and things were close to schedule but slightly behind schedule. So, we needed to pick up the pace to enable the team to finish on time”, “we can’t afford to lose a day”, or “They would not check it. So, we would have one or two delays before they get the information… And the process was extremely important at that point, because we need to know exactly what was the code that they were delivering. We need to know exactly what are the issues there, fixed in the code they’re delivering based on the QA that we did the previous day.” Even one day lost was too many for
most of these projects. These projects did not have much slack time in their schedules as a whole. This agrees with prior studies of virtual teams (Powell et al. 2004).

In 19 projects (63%), there were formal orientations planned and executed during the start-up period of the project. These had varying degrees of comprehensiveness. Some covered topics such as training on the ICTs to be used, explanation of their features and limitations, what to do if they fail, and how they integrate with the project task and other members’ work. Most of the orientations covered aspects of the team interaction and job/task issues including the task procedures, roles and responsibilities, information flow and interdependencies, and subtasks and their constraints. The team membership getting-to-know-you was addressed virtually in two cases, one in which member photos and profiles were exchanged and one in which online socializing over instant messaging was encouraged up front.

Other than these two examples, the getting-to-know-you part was largely developed either up front in face-to-face meetings or through interactions later during work. One leader captured the content of the initial orientation into a self-guided presentation that members could access in a shared space when joining the team later on. In three cases, leaders stopped the project work mid-process to re-orient the team, training them for two days to a week on new a new piece of technology that would be used from then on. The dearth of up-front training that covered ICTs and how and why to use them seemed foreboding, since many of these projects were reported because they ended up with problems that necessitated technology facilitation.

Overall, the project contexts encountered presented far more volatility and complexity than we found in the empirical studies we had examined. It became clear to us that the virtual team is a moving target in which a critical contextual variable, the team membership, may change fairly frequently during the life of the team.
4.2.1 Description of ICTs Used in Projects

The leaders reported their teams using median of 12.5 ICTs each (Table 9). This is a very surprising finding, considering that most prior research has examined only one or a few ICTs at a time. This brings the applicability of much prior research into question, given that limiting the number of ICTs involved in a team reduces the complexity the team faces and the number of potential confounding factors. The minimum number of ICTs used in any project was 7 and the maximum was 18 (Table 9).

As shown in Table 10, three ICTs were used in 100% of the projects. Every team had phone, email, and an audio conferencing tool. The other most common tools reported in at least 20 (66%) projects were project management tools, fax, calendar, development environment tools, document versioning tools file servers, instant messaging, and teamspaces. Some tools were used constantly by most teams, like phone and email, while others, such as fax, were rarely used. Even if a project had only a few ICTs categorically, it might have had multiple versions or types of ICT within a category. For example, in three cases, different versions of scheduling and instant messaging ICTs were not compatible, and the incompatibility was only discovered once the project work was in progress. These incompatibilities fed communication problems.
Table 10: Percent and Count of 30 Projects in Which Various ICTs Were Used

<table>
<thead>
<tr>
<th>Percent</th>
<th>Audio Conferencing</th>
<th>Calendar</th>
<th>Chat</th>
<th>Desktop sharing</th>
<th>Development support</th>
<th>Document versioning</th>
<th>Email</th>
<th>Fax</th>
<th>File servers</th>
<th>Group decision tool</th>
<th>Groupware / teamspace</th>
<th>Instant messaging</th>
<th>Postal mail</th>
<th>Knowledge portal</th>
</tr>
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<tbody>
<tr>
<td>St Dev</td>
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<td>0.43</td>
<td>0.45</td>
<td>0.51</td>
<td>0.43</td>
<td>0.45</td>
<td>0.00</td>
<td>0.41</td>
<td>0.47</td>
<td>0.41</td>
<td>0.47</td>
<td>0.45</td>
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<td>6</td>
<td>21</td>
<td>22</td>
<td>18</td>
<td>17</td>
</tr>
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<td>Project management tool</td>
<td>Phone</td>
<td>Threaded discussion</td>
<td>Video conferencing</td>
<td>Virtual meeting tool (synchronous)</td>
<td>Web pages</td>
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<tr>
<td>80%</td>
<td>100%</td>
<td>43%</td>
<td>23%</td>
<td>57%</td>
<td>37%</td>
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</tbody>
</table>
4.3 Description of Critical Incidents Found

We captured 52 complete incidents of technology facilitation in the interviews (Table 11). A complete incident is one in which we could find clear evidence of the four essential time points that describe an incident – triggers, actions, structural changes, and outcomes. These interviews were assigned an ID based on their interview ID and Project ID. Thus, the first incident in Table 11 has the ID “I22P1C1” meaning incident 22, project one, critical incident one. These project numbers correspond with the project IDs reported for each project (Table 9) and the leader IDs (Table 8).

<table>
<thead>
<tr>
<th>ID</th>
<th>Reference Name</th>
<th>Result</th>
<th>Stage</th>
<th>View</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>I22P1C1</td>
<td>CVS use faithfulness</td>
<td>Effective</td>
<td>Late</td>
<td>Facilitator</td>
<td>1 hour</td>
</tr>
<tr>
<td>I22P2C2</td>
<td>Document Version &quot;Sneaker Net&quot;</td>
<td>Both</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2+ weeks</td>
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<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
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<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-4 hours</td>
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<tr>
<td>I23P1C1</td>
<td>Japan Email</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
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<td>I23P1C2</td>
<td>MS Project</td>
<td>Effective</td>
<td>Late</td>
<td>Facilitator</td>
<td>1 week</td>
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<td>Early</td>
<td>Facilitator</td>
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<td>Start-up</td>
<td>Facilitator</td>
<td>1 day</td>
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<tr>
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<td>Reference Name</td>
<td>Result</td>
<td>Stage</td>
<td>View</td>
<td>Duration</td>
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<td>I25P1C4</td>
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<td>Effective</td>
<td>Early</td>
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<td>Facilitator</td>
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<td>Facilitator</td>
<td>6 weeks</td>
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<td>I26P1C1</td>
<td>eMtg Demo</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
<tr>
<td>I26P1C4</td>
<td>&quot;Cruisers&quot;</td>
<td>Both</td>
<td>Start-up</td>
<td>Member</td>
<td>5 days</td>
</tr>
<tr>
<td>I26P2C2</td>
<td>Telecom Protocol</td>
<td>Effective</td>
<td>Start-up</td>
<td>Facilitator</td>
<td>2 months</td>
</tr>
<tr>
<td>I26P2C3</td>
<td>Application Simulation Demo</td>
<td>Effective</td>
<td>Late</td>
<td>Facilitator</td>
<td>2 weeks</td>
</tr>
<tr>
<td>I27P1C1</td>
<td>UML tool</td>
<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>I27P1C2</td>
<td>Threaded Email Flaming</td>
<td>Both</td>
<td>Middle</td>
<td>Member</td>
<td>6 months</td>
</tr>
<tr>
<td>I27P2C3</td>
<td>Email Repository</td>
<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2 months</td>
</tr>
<tr>
<td>I27P1C4</td>
<td>Message Labeling [Flagging]</td>
<td>Effective</td>
<td>Middle</td>
<td>Member</td>
<td>2 months</td>
</tr>
<tr>
<td>I27P2C5</td>
<td>TWIKI CVS</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1-2 weeks</td>
</tr>
<tr>
<td>I28P1C1</td>
<td>Dial-in Audio Conf</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 hour</td>
</tr>
<tr>
<td>I28P1C2</td>
<td>WIKI initial</td>
<td>Effective</td>
<td>Start-up</td>
<td>Facilitator</td>
<td>1 month</td>
</tr>
<tr>
<td>I28P1C3</td>
<td>WIKI fake login</td>
<td>Effective</td>
<td>Middle</td>
<td>Member</td>
<td>1 week</td>
</tr>
<tr>
<td>I28P1C4</td>
<td>Workflow System Improvement</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2 weeks</td>
</tr>
<tr>
<td>I29P1C1</td>
<td>WebEx</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 day</td>
</tr>
<tr>
<td>I29P1C2</td>
<td>Intercompany Process</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-3 days</td>
</tr>
<tr>
<td>I29P2C3</td>
<td>Email Repository</td>
<td>Both</td>
<td>Early</td>
<td>Facilitator</td>
<td>2+ months</td>
</tr>
<tr>
<td>I30P1C1</td>
<td>Proj. Mgmt. Tools</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2 weeks</td>
</tr>
<tr>
<td>ID</td>
<td>Reference Name</td>
<td>Result</td>
<td>Stage</td>
<td>View</td>
<td>Duration</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
<td>------------</td>
<td>---------</td>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>I30P2C2</td>
<td>Screen Sharing</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-3 days</td>
</tr>
<tr>
<td>I30P3C3</td>
<td>File Sharing</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 day</td>
</tr>
<tr>
<td>I31P1C1</td>
<td>MS Proj./ Excel</td>
<td>Effective</td>
<td>Late</td>
<td>Member</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>I31P1C2</td>
<td>New Page Design</td>
<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>I31P2C3</td>
<td>Screen Sharing Attempt</td>
<td>Ineffective</td>
<td>Early</td>
<td>Facilitator</td>
<td>1 day</td>
</tr>
<tr>
<td>I31P2C4</td>
<td>IM attempt: failed</td>
<td>Ineffective</td>
<td>Early</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
<tr>
<td>I31P2C5</td>
<td>IM attempt: success</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
<tr>
<td>I32P1C1</td>
<td>Email tone</td>
<td>Effective</td>
<td>Start-up</td>
<td>Facilitator</td>
<td>2 months</td>
</tr>
<tr>
<td>I32P1C2</td>
<td>Bringing X into the Room</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
<tr>
<td>I32P1C3</td>
<td>Message norm: CCing</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>6 months</td>
</tr>
<tr>
<td>I32P1C4</td>
<td>OO Tool implementation</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>6 months</td>
</tr>
<tr>
<td>I34P1C1</td>
<td>FTP Server</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>3 days</td>
</tr>
<tr>
<td>I34P2C2</td>
<td>3 Custom Report Tools</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>2+ months</td>
</tr>
<tr>
<td>I34P3C3</td>
<td>VPN Failure</td>
<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>3 days</td>
</tr>
<tr>
<td>I34P4C4</td>
<td>Remote Logins Permissions</td>
<td>Ineffective</td>
<td>Early</td>
<td>Facilitator</td>
<td>3 days</td>
</tr>
<tr>
<td>I35P1C1</td>
<td>Self-Governing Facility</td>
<td>Effective</td>
<td>Start-up</td>
<td>Facilitator</td>
<td>2 weeks</td>
</tr>
<tr>
<td>I35P2C2</td>
<td>Creative/IT Communication</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-3 weeks</td>
</tr>
<tr>
<td>I35P3C3</td>
<td>Audio Conf. Force Handling</td>
<td>Effective</td>
<td>Early</td>
<td>Facilitator</td>
<td>3 months</td>
</tr>
<tr>
<td>I35P3C4</td>
<td>Security Policy Change</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>a week</td>
</tr>
<tr>
<td>I36P1C1</td>
<td>Logging DB Feature</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2 weeks</td>
</tr>
<tr>
<td>I36P1C2</td>
<td>Occasional Conference Call</td>
<td>Effective</td>
<td>Late</td>
<td>Facilitator</td>
<td>1 day</td>
</tr>
<tr>
<td>I36P2C3</td>
<td>Live Data Stream</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
</tbody>
</table>
Summary data was tabulated for each incident in both textual and graphical form. Summary data on the 52 incidents are presented in Table 11. Appendix K contains this same data plus a one-paragraph textual summary of what happened in each incident. Appendix W contains two examples of graphical summaries of the incidents. While these summaries have served a useful role in helping to collate and remember key points in the data, they were not critical to the analysis design per the research questions and have not been used in-depth in the analysis in this study.

Effectiveness of the incidents varied. We collected the leader’s self-reported effectiveness, and we judged effectiveness based on their reported outcomes. Most incidents were placed in the same category as judged by the interviewees. Three were converted to the “both” category, because they displayed mixed results- some effectiveness and some ineffectiveness. We found 36 effective incidents (69%), nine ineffective incidents (17%), and seven incidents with mixed results (13%).

The incidents were distributed across the scope of the projects. Six began during project start-up, 13 during “ramp-up” or an early stage, 26 during the middle or main production period for the team, and seven at the end or late in the project (Table 12).
We also collected incidents from multiple viewpoints. The majority of the incidents were reported by the leader who acted as the technology facilitation (47 incidents, 90%). Five incidents were reported by leaders who were observing another leader on the team during the incident. These are marked “Member” in the “View” column of Table 11. We did not recognize any pattern with regard to the interviewee’s reporting on another leader’s incidents.

The distribution of critical incidents by duration was definitely not normal (Figure 4). Two incidents resolved in an hour or less. According to a histogram of the data, the grand majority (38 incidents, 73%) required three to four weeks to complete, and then two bulges occur, one at 11 weeks (6 incidents, 12%) and another at half a year or more (3 incidents, 6%). The standard deviation for the incident duration was 43 and a half days with a median duration of seven days. Overall, the incident durations displayed a lot of variance. If one centers the 43.5-day standard deviation on three to four weeks, or 25 days, one can see that the three-to-four week category statistically spans from a few days to almost two months. So, most incidents complete within two months, but that still leaves a small tail of very short incidents and bulges at longer durations.
On closer examination, some facilitations were nearly instantaneous, such as correcting a clearly wrong behavior (I22P1C1), expanding use of an already well-used and well-understood ICT (I29P1C1) or switching to a nearly identical technology that would be a bit easier (I28P1C1), and some lasted months, especially when changing day-to-day habits were involved, such as in I29P2C3, I32P1C1, and I32P1C3.

Figure 4: Distribution of Incidents by Duration
4.4 Overview of Main Study Deliverables

The following five sections present the main deliverables of this study that answer the research questions raised in Chapter 1 (Table 2). The five sections correspond to the five “root categorizations” identified as key to a structuring episode and technology facilitation critical incident in Chapter 3. These five root categorizations are also referred to as the critical incident categories in the following sections. They are pictured in Figure 5: 1) structural triggers or “triggers”, 2) leader actions or “actions”, 3) structural changes or “changes”, 4) team outcomes or “outcomes”, and 5) mental model beliefs or “beliefs.”

![Figure 5: Five Elements of a Technology Facilitation Critical Incident](image)

Each section contains a table listing the main dimensions or categories within each critical incident category. These are referred to by the category short name. So, for example, the table of trigger dimensions is called, “Technology Facilitation Triggers” Table 13. There is also a longer table in each section that presents the analytical data used to develop the dimensions. These tables include all of the individual theme codes the judges grouped into the various
dimensions during the coding and content analysis process described in Chapter 3. Prevalence statistics are also reported in these longer tables.

We report the number of interviews and incidents in which each dimension and each theme code were found, as well as, the number of quotations in the transcript that are associated with each theme code. Finally, we report the weight statistic we derived to combine the interview and incident data into one summary number that could help define the total prevalence of each theme code and dimension. The weight statistic was based primarily on the interview count since the interview count represents 2/3 of the weight’s weight. The weight statistic was useful in that in a few cases the interview count alone did not adequately represent the prevalence of a theme code or dimension. This seemed to happen when there was a particular theme that a smaller number of interviewees ran into a lot. For example, we suspect the people working in the larger, more global projects ran into international cultural issues more than people in the smaller, less global projects. As a result, the incident count for international culture may have been very high though the interview count was relatively lower. The weight statistic was able to pick up on this and show an increased prevalence. This weight statistic is used to order the items in the tables and is intended only as an aid in determining how prevalent the phenomena were in the data. Frequency alone does not indicate the importance of a critical incident code, but it does provide a starting point for further analysis as an estimation of the amount of grounding an item has (Hopkins 1987).

In the analysis of each dimension, we attempted to determine what sub-themes or sub-categories might be at work within the individual dimensions. This was done by taking the first code by weight and looking through the other codes in its dimension’s section to find others that could plausibly be associated with it. Then, the next theme code that was not included in the first
theme code’s sub-category was taken as the seed of the next sub-category and so on. Most dimensions ended up with two or three sub-categories or theme groupings in this manner. There are likely to be other possible sub-groupings of the theme codes. Nonetheless, we found these groupings useful in interpreting the dimensions and telling a story about what they mean.

4.5 Categorization of Triggers

Triggers are the phenomena or conditions that lead a leader to take action in facilitating technology use in a virtual team. Temporally, they are the first step in a technology facilitation critical incident (Figure 5). The judges agreed that there are two overriding types of triggers, proactive or opportunity-focused and reactive or problem-focused. They created the six trigger categorizations then reached consensus on these two types during discussion, identifying one proactive and five reactive categories (Table 13).

While all of the triggers were broadly supported (minimum weight of 57.05 calculated from Member Knowledge triggers appearing in 9 interviews and 17 incidents), with at least nine of the thirteen interviews (69%) and sixteen of the fifty-two individual incidents (30%) providing evidence of the least frequently supported ones—member knowledge and interference of group structure—, the prevalence did vary according to our weight statistic (Table 13). The most prevalent triggers were externals to the team interfering and tools being inadequate, with very high weights in the 80s. The least prevalent was member knowledge followed by interference of group structure with weights of 57.05 and 61.54 respectively.
Table 13: Technology Facilitation Triggers

<table>
<thead>
<tr>
<th>Trigger Dimension</th>
<th>Type</th>
<th>Trigger Source</th>
<th>Trigger Dimension</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity</td>
<td>Actor</td>
<td>Leader knowledge</td>
<td></td>
<td>11</td>
<td>35</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85%</td>
<td>67%</td>
<td>78.85</td>
</tr>
<tr>
<td>Problem</td>
<td>Task, technology, &amp;</td>
<td>Externals to team interfere</td>
<td></td>
<td>13</td>
<td>31</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>organizational</td>
<td></td>
<td></td>
<td>100%</td>
<td>60%</td>
<td>86.54</td>
</tr>
<tr>
<td></td>
<td>context</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Tool is inadequate</td>
<td></td>
<td></td>
<td>12</td>
<td>37</td>
<td>71%</td>
</tr>
<tr>
<td>People</td>
<td>Trust and relationship</td>
<td></td>
<td></td>
<td>12</td>
<td>25</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>breakdown</td>
<td></td>
<td></td>
<td>92%</td>
<td>48%</td>
<td>77.56</td>
</tr>
<tr>
<td>People &amp; technology</td>
<td>Interference of group</td>
<td></td>
<td></td>
<td>10</td>
<td>16</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>structure</td>
<td></td>
<td></td>
<td>77%</td>
<td>31%</td>
<td>61.54</td>
</tr>
<tr>
<td>People &amp; technology</td>
<td>Member knowledge</td>
<td></td>
<td></td>
<td>9</td>
<td>17</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>69%</td>
<td>33%</td>
<td>57.05</td>
</tr>
</tbody>
</table>

As a technology facilitation trigger, leader knowledge had an opportunity focus. Within its most heavily weighted theme codes, three themes stuck out defining how leader knowledge acts as a trigger (Table 14). These are: 1) leaders awareness of having an ICT solution or resources available (codes 9 and 429), 2) the leader knowing about ICTs and how they can operate in team interaction in general (codes 296, 303, 389, 304, 362, 361, 294, 363, and 463), and 3) the leader knowing the specific people in his virtual team and how they prefer to use ICT (codes 45 and 484). The theoretical source of the leader knowledge trigger is neither physical nor manifest. It relies on an individual leader’s knowledge and ability to conceive of an
opportunity on her own. This is a surprising finding in that we had only listed task, technology, and people structures as possible trigger sources in our conceptual framework (Figure 2). However, the individual knowledge and skills of the leader does conceptually fall within the domain of people structure. Since the leaders and their actions were a primary focus of this study, we extracted them from the people input structure for intense examination. In that examination, we found this opportunity trigger that comes specifically from the actor herself (Table 13).

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A tool solution was readily available</td>
<td>58.33</td>
<td>9</td>
<td>69%</td>
<td>19</td>
</tr>
<tr>
<td>296</td>
<td>Leader experience (knowledge) of better tool</td>
<td>44.87</td>
<td>7</td>
<td>54%</td>
<td>14</td>
</tr>
<tr>
<td>303</td>
<td>Leader thought that using different tool would be more effective</td>
<td>35.9</td>
<td>6</td>
<td>46%</td>
<td>8</td>
</tr>
<tr>
<td>45</td>
<td>Clear preference or capability on one tool or another</td>
<td>26.28</td>
<td>4</td>
<td>31%</td>
<td>9</td>
</tr>
<tr>
<td>389</td>
<td>Possibilities of a new technology enticed leader</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>304</td>
<td>Leader thought using tool(s) differently would be more effective</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>362</td>
<td>Opportunity to share information between team groups better</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>429</td>
<td>Resources available to make change</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>361</td>
<td>Opportunity to improve on way(s) of interacting</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>294</td>
<td>Leader could change self without changing others</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>363</td>
<td>Opportunity to upgrade tool at team startup</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>398</td>
<td>Product delivered on time</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>463</td>
<td>Team member shared knowledge of better tool</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>484</td>
<td>Thought leader/ tool champion in other group existed</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Externals to team interfere**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>491</td>
<td>Time pressure / lack of time to complete task/ project</td>
<td>56.41</td>
<td>9</td>
<td>69%</td>
<td>16</td>
</tr>
<tr>
<td>366</td>
<td>Organizational policy restricted tool</td>
<td>46.15</td>
<td>8</td>
<td>62%</td>
<td>8</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>377</td>
<td>Permissions / Access problem</td>
<td>41.03</td>
<td>7</td>
<td>54%</td>
<td>8</td>
</tr>
<tr>
<td>297</td>
<td>Leader hired to enable change</td>
<td>34.62</td>
<td>6</td>
<td>46%</td>
<td>6</td>
</tr>
<tr>
<td>391</td>
<td>Pressure to complete this project right</td>
<td>29.49</td>
<td>5</td>
<td>38%</td>
<td>6</td>
</tr>
<tr>
<td>403</td>
<td>Project delays created ripple effect / rework</td>
<td>17.95</td>
<td>3</td>
<td>23%</td>
<td>4</td>
</tr>
<tr>
<td>71</td>
<td>Cost as choice factor in tool selection or usage</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>134</td>
<td>Escalation of work performance problems cause higher management</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>48</td>
<td>Client requested that team use a new tool to try it out</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>300</td>
<td>Leader promoted to enable change</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>407</td>
<td>Project timeline/ production constraints</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Tool is inadequate**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Clear evidence visible to all that current tool(s)/ way(s) of interacting</td>
<td>58.33</td>
<td>9</td>
<td>69%</td>
<td>19</td>
</tr>
<tr>
<td>8</td>
<td>A tool feature was needed but missing</td>
<td>50.64</td>
<td>8</td>
<td>62%</td>
<td>15</td>
</tr>
<tr>
<td>356</td>
<td>No common repository / shared information space existed</td>
<td>35.26</td>
<td>6</td>
<td>46%</td>
<td>7</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>498</td>
<td>Tool not accessible and/or reliable enough</td>
<td>35.26</td>
<td>6</td>
<td>46%</td>
<td>7</td>
</tr>
<tr>
<td>116</td>
<td>Email overload, too many</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>144</td>
<td>File sharing not possible with existing tool(s)</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>298</td>
<td>Leader needed synchronous meeting tool with visual control and</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>467</td>
<td>Team members had different versions of tool(s)</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>138</td>
<td>Existing tools not interoperable / interconnected</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>283</td>
<td>Information was inaccurate</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>120</td>
<td>Email unable to handle conflict resolution between individuals in</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>121</td>
<td>Email was unable to keep track of different document/code versions</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>499</td>
<td>Tool poorly implemented/ configured</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>342</td>
<td>Needed verbal channel</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>343</td>
<td>Needed visual control of other's screens</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>497</td>
<td>Tool features poorly designed / inefficient</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Trust and relationship breakdown**
<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>299</td>
<td>Leader noticed that communication was not working</td>
<td>48.08</td>
<td>8</td>
<td>62%</td>
<td>11</td>
</tr>
<tr>
<td>322</td>
<td>Members of different groups had conflicting data and opinions</td>
<td>41.67</td>
<td>7</td>
<td>54%</td>
<td>9</td>
</tr>
<tr>
<td>288</td>
<td>Lack of trust in professional skills between individuals in different</td>
<td>30.13</td>
<td>5</td>
<td>38%</td>
<td>7</td>
</tr>
<tr>
<td>392</td>
<td>Private communications among team members disabled collaboration</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>469</td>
<td>Team members had interpersonal conflict/ lack of trust/ relations</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>360</td>
<td>One or more team members didn't respond, went dark</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>357</td>
<td>No regular communication/ interaction</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>359</td>
<td>One group shirks responsibility to another due to interaction</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Interference of group structure**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>323</td>
<td>Members were physically distant from one another</td>
<td>34.62</td>
<td>6</td>
<td>46%</td>
<td>6</td>
</tr>
<tr>
<td>475</td>
<td>Team size grew</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
</tr>
<tr>
<td>474</td>
<td>Team size bigger than usual tools and</td>
<td>17.95</td>
<td>3</td>
<td>23%</td>
<td>4</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>289</td>
<td>Language / Cultural misunderstanding</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>162</td>
<td>Had to work across multiple organizations</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>338</td>
<td>Multiple team member locations</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>488</td>
<td>Time differences among members disable an option</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>250</td>
<td>Inability to coordinate</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>341</td>
<td>Needed to enable multi-tasking and member accessibility</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Member knowledge**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>373</td>
<td>People couldn’t be corralled / convinced using existing tools</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
</tr>
<tr>
<td>376</td>
<td>People were not using the tools properly / professionally</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>468</td>
<td>Team members had inadequate task knowledge</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>464</td>
<td>Team members' lack of experience</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>471</td>
<td>Team members using tool features in an unacceptable way</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>494</td>
<td>Tool assigned but not getting used</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
</tbody>
</table>
Externals to a team interfered and cause problems. This was the most prevalent trigger, occurring in all of the interviews and 60% of the incidents. This trigger had three major themes: 1) time or the project schedule imposed on the team (codes 491, 391, 403, and 407), 2) organizational and larger policy issues interfering (codes 366 and 377), and 3) intentional efforts by upper management to influence change in the project (codes 297, 134, 48, and 300) (Table 14). These three themes related to the theoretical base of this study in that time and project schedule issues have to do with task structure, organizational and policy issues as well as upper management influence have to do with organizational context. In that they prompted technology facilitation and were perceived by the leader in relation to ICT, they are associated with technology. These theoretical sources are listed in Table 13.

Current information and communication technologies were frequently inadequate as virtual team tools, with inadequate tool triggers occurring in 92% of the interviews and 71% of the incidents (Table 13). This trigger had two aspects: 1) a tool was not working, perhaps because of availability or reliability issues, not enough capacity, or lack of inter-operability (codes 44, 498, 116, 467, 138, and 499), and 2) a tool feature or whole tool was missing and
could not be handled by existing tools (codes 8, 356, 144, 298, 283, 120, 342, 343, and 497) (Table 14). This trigger sourced from technology alone. It provides a deep criticism of the current state of ICTs that the inadequacy of tools often causes team interaction problems.

Trust and relationship breakdowns proved common and able to short-circuit team interaction regardless of technology (Table 13). This trigger had three aspects: 1) communication was not working in general (codes 299, 392, 360, and 357), 2) intra-team conflict arose and could not be solved by members on their own (codes 322 and 259), and 3) trust between members soured and damaged relations (codes 288 and 469) (Table 14). This trigger’s source surprised us. It did not seem related to technology from inception. Rather, it seemed to originate wholly with the people structure and intra-team trust and relations.

Teams’ internal group structure also interfered (Table 13). This trigger mirrored much of the existing virtual team literature’s discussion of difficulties due to virtuality and global composition (Powell et al. 2004). The main factors of interference of group structure were: 1) time and space dispersion (codes 323, 338, and 341), 2) team size (codes 475, 474, and 250), and 3) team member demographics (codes 289 and 162). These three factors find wide support in a substantial body of prior research that has focused on time-space dispersion issues in computer-mediated team interaction (e.g. Johansen 1988), organizational and cultural barrier crossing issues (e.g. Thompson 1967; Watson et al. 1994), and group size issues (e.g. Hare et al. 1994). This trigger originated in people-technology issues in that dispersion, team size, and functional composition choices to include various groups are part of a project’s people structure as it relates to technology.

The final problem trigger was team members’ knowledge or lack thereof and consequent use or disuse of tools also triggered technology facilitation (Table 13). Two factors contributed
to this trigger: 1) a tool was workable but not effective the way members were understanding it or using it (codes 373, 376, 471, and 494), and 2) team members lacked knowledge or experience to use a tool (codes 468, 464, 286, and 448) (Table 14). Here the trigger source was the technology-people structure interaction.

Five of the six trigger categories were reactive or problem-focused and they were very prevalent in the data. Virtual team leaders often seem to be engaging in technology facilitation due to problems. We calculated the percentage of incidents in which each trigger dimension occurred to help understand how common the various triggers were in the incidents (Table 13). Clearly, there were multiple triggers in many of the incidents. With multiple triggers in each incident, it is certain that VT leaders face a complex task facilitating technology use. Many of the incidents involved not only a problem trigger but also the leader interpreting that problem and seeing an opportunity.

Most incidents had five or six trigger theme codes associated with them, some has as many as 10 or more. When these were filtered to represent only the trigger dimensions found by the judges, the number of triggers occurring in each incident dropped to between two and three. Four triggers share the top spots in terms of frequency of occurrence. These are tools being inadequate, leader knowledge, trust and relationship breakdowns, and externals to the team interfering. While there has been some research on trust in VTs, there has been little research on what leaders need to know, how tools can be adequate, and what to do about externals to the team interfering.

Much research time has been spent on group internal structure, and perhaps the fruit of that research is that group internal structure does not show up as a cause of technology facilitation so frequently as the others. As for member knowledge, its infrequency may result
from several possible factors. It may be that successful VT leaders are hesitant to use the common programmer mantra of “user error” to explain problems. They may be more likely to accept the team members at their current knowledge levels and attempt to change or manipulate other technology facilitation levers to make team interaction work.

4.6 Categorization of Actions

Technology facilitation actions fell into eight categories (Table 15). All of the action categories showed substantial support from the interview data with the least evidenced category—modifying tasks—evidenced in nine incidents and eight interviews. The judges did not recognize any higher-order pattern among the actions, but the theoretical base underlying this study—AST—did suggest different appropriation process targets among the actions. The primary goal of technology facilitation is improving team interaction through the use of ICTs. Following the logic of this goal, changing the ICT structure in the team becomes a primary goal of technology facilitation.

Changing the people and team structures becomes corollary structural change in order to support introducing new tools or dealing with existing tools, and actions taken to motivate appropriation form a separate category that does not specifically target structural change as much as driving the change process. Three actions fit in this appropriation support category. Two of them, training and persuading and setting and enforcing rules, focus on motivating but also contain theme codes relating to changing the people structure. As such, they have sub-categories that target people structure change. Like the triggers, multiple actions occurred in the critical incidents. It was common for a leader to both have to deal with existing tools and introduce new tools simultaneously, and she would also frequently have to add in other corollary structural change actions and appropriation actions. The third appropriation support action, monitoring
interaction, forms a separate category, in that it may occur at any time during team interaction whereas the appropriation support actions would only occur while a team is appropriating one or more specific technologies.

Table 15: Technology Facilitation Actions

<table>
<thead>
<tr>
<th>Action Type</th>
<th>Target</th>
<th>Action</th>
<th>Dimension</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary structure manipulation</td>
<td>Structure: technology</td>
<td>Introducing new tools</td>
<td>Technology</td>
<td>12</td>
<td>92%</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Structure: technology</td>
<td>Dealing with existing tools</td>
<td>Technology</td>
<td>11</td>
<td>85%</td>
<td>21</td>
</tr>
<tr>
<td>Corollary structure manipulation</td>
<td>Structure: people</td>
<td>Rearranging people</td>
<td>Structure: people</td>
<td>10</td>
<td>77%</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Structure: tasks</td>
<td>Modifying tasks</td>
<td>Structure: tasks</td>
<td>8</td>
<td>62%</td>
<td>9</td>
</tr>
<tr>
<td>Appropriation support</td>
<td>Appropriation &amp; Structure: people</td>
<td>Training and persuading</td>
<td>Structure: people</td>
<td>12</td>
<td>92%</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Appropriation &amp; Structure: all</td>
<td>Initializing team interaction</td>
<td>Structure: all</td>
<td>11</td>
<td>85%</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Appropriation &amp; Structure: people</td>
<td>Setting and enforcing rules</td>
<td>Structure: people</td>
<td>11</td>
<td>85%</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>Monitoring interaction</td>
<td></td>
<td>10</td>
<td>77%</td>
<td>21</td>
</tr>
</tbody>
</table>
The first primary action, introducing new tools, had three aspects: 1) finding and acquiring new tools (codes 145, 20, 19, 147, 309, and 21), 2) making a new tool operational (codes 52, 386, and 28), and 3) creating a new tool (codes 402 and 75) (Table 16). This last aspect was surprising. Two virtual team leaders interviewed actually programmed a new ICT during their projects when a problem arose. The other two aspects require in-depth knowledge of ICTs. We had already discovered that leader ICT knowledge could trigger technology facilitation. Thus, upon examination of this action, we expected even more that virtual team leaders must know about and know how to learn about available ICTs in order to be successful.

### Table 16: Analysis of Action Dimensions

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introducing new tools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>Finds better tool and adds it</td>
<td>35.9</td>
<td>6</td>
<td>8</td>
<td>15%</td>
</tr>
<tr>
<td>52</td>
<td>Commits initial use of new tool</td>
<td>28.85</td>
<td>5</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>20</td>
<td>Adds a synchronous voice communication tool</td>
<td>23.08</td>
<td>4</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>402</td>
<td>Programs (makes) new feature / tool</td>
<td>17.95</td>
<td>3</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>19</td>
<td>Adds a new tool</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>75</td>
<td>Creates common repository / knowledge base</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>386</td>
<td>Pilots tests new tool before using for real project work</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>28</td>
<td>Assigns one person to administer complex tool being added</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>147</td>
<td>Finds tool to fill a task need and adds it</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>309</td>
<td>Learns new tool</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>Adds a tool to enable new task</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Dealing with existing tools**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>Develops consensus that there is a problem with a tool or the way it</td>
<td>29.49</td>
<td>5</td>
<td>38%</td>
<td>6</td>
</tr>
<tr>
<td>124</td>
<td>Emphasizes use of existing tool(s)</td>
<td>19.23</td>
<td>3</td>
<td>23%</td>
<td>6</td>
</tr>
<tr>
<td>379</td>
<td>Personally installs and uses interoperable tool(s) to match others'</td>
<td>17.95</td>
<td>3</td>
<td>23%</td>
<td>4</td>
</tr>
<tr>
<td>417</td>
<td>Recommends better use of existing tool</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>319</td>
<td>Makes tool more accessible</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>420</td>
<td>Reconfigures tool to improve use</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Initializing team interaction**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>438</td>
<td>Sets up tool(s) for initial use</td>
<td>67.31</td>
<td>11</td>
<td>85%</td>
<td>17</td>
</tr>
<tr>
<td>52</td>
<td>Commits initial use of new tool</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
</tr>
<tr>
<td>89</td>
<td>Designs tool(s) into initial project communication plan</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
</tr>
<tr>
<td>84</td>
<td>Delegates technology facilitation tasks to</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>386</td>
<td>Pilots tests new tool before using for real project work</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>86</td>
<td>Designs communication using comfort tool(s)</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>88</td>
<td>Designs project with extra resources to handle problems</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>418</td>
<td>Recommends a better tool at design time</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>76</td>
<td>Creates formal tool use norm documentation</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>87</td>
<td>Designs complex tool use to minimize organizational barriers must be</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>430</td>
<td>Restricts tool use to minimum users necessary</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>438</td>
<td>Sets up tool(s) for initial use</td>
<td>67.31</td>
<td>11</td>
<td>85%</td>
<td>17</td>
</tr>
<tr>
<td>52</td>
<td>Commits initial use of new tool</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
</tr>
</tbody>
</table>

**Rearranging people**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>159</td>
<td>Gets permissions / access arranged</td>
<td>29.49</td>
<td>5</td>
<td>38%</td>
<td>6</td>
</tr>
<tr>
<td>423</td>
<td>Reduces virtuality by moving people</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
</tr>
<tr>
<td>84</td>
<td>Delegates technology facilitation tasks to team members</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>337</td>
<td>Moves people to reduce use of complex tool</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>410</td>
<td>Rearranges people to accommodate tool</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>43</td>
<td>capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Changes team member's role</td>
<td>5.77</td>
<td>1</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Modifying tasks**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>412</td>
<td>Rearranges task to accommodate tool capability</td>
<td>17.95</td>
<td>3</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>84</td>
<td>Delegates technology facilitation tasks to team members</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>411</td>
<td>Rearranges schedule to accommodate synchronous tool use</td>
<td>11.54</td>
<td>2</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>413</td>
<td>Rearranges task(s) to enable tool use</td>
<td>5.77</td>
<td>1</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Training and persuading**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>Discusses tool use with team to establish use policy</td>
<td>41.67</td>
<td>7</td>
<td>9</td>
<td>17%</td>
</tr>
<tr>
<td>501</td>
<td>Train team on new tool</td>
<td>30.13</td>
<td>5</td>
<td>7</td>
<td>13%</td>
</tr>
<tr>
<td>63</td>
<td>Convinces members to use tool(s) through discussion</td>
<td>29.49</td>
<td>5</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>129</td>
<td>Encourages open communication</td>
<td>23.72</td>
<td>4</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>92</td>
<td>Develops consensus that benefit of tool(s) outweighs effort to</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>135</td>
<td>Establishes regular communication pattern/</td>
<td>11.54</td>
<td>2</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>158</td>
<td>expectation</td>
<td>11.54</td>
<td>2</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>502</td>
<td>Gets other team leaders on board</td>
<td>11.54</td>
<td>2</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>60</td>
<td>Trains members on new tool co-located</td>
<td>5.77</td>
<td>1</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>427</td>
<td>Conditions team to expect tool changes during project</td>
<td>5.77</td>
<td>1</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>428</td>
<td>Reminds members to use tool (common repository)</td>
<td>5.77</td>
<td>1</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>96</td>
<td>Discusses tool use with team to establish use policy</td>
<td>41.67</td>
<td>7</td>
<td>9</td>
<td>54%</td>
</tr>
</tbody>
</table>

**Setting and enforcing rules**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>Escalates issue to apply higher management pressure</td>
<td>28.85</td>
<td>5</td>
<td>5</td>
<td>38%</td>
</tr>
<tr>
<td>320</td>
<td>Mandates way of interacting/ using tool</td>
<td>28.85</td>
<td>5</td>
<td>5</td>
<td>38%</td>
</tr>
<tr>
<td>332</td>
<td>Modifies team communication policy</td>
<td>24.36</td>
<td>4</td>
<td>6</td>
<td>31%</td>
</tr>
<tr>
<td>26</td>
<td>Applies social pressure (shame, guilt) to support use compliance</td>
<td>23.08</td>
<td>4</td>
<td>4</td>
<td>31%</td>
</tr>
<tr>
<td>61</td>
<td>Confronts unacceptable use</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>23%</td>
</tr>
<tr>
<td>36</td>
<td>Blocks use of alternate tool</td>
<td>5.77</td>
<td>1</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>76</td>
<td>Creates formal tool use norm documentation</td>
<td>5.77</td>
<td>1</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>333</td>
<td>Monitors tool use to assess quality</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>416</td>
<td>Recognizes unacceptable use</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>435</td>
<td>Sanctions unacceptable use</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Monitoring interaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>146</td>
<td>Finds reason for problem</td>
<td>42.31</td>
<td>7</td>
<td>54%</td>
<td>10</td>
</tr>
<tr>
<td>415</td>
<td>Recognizes that tool is not working well</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
</tr>
<tr>
<td>419</td>
<td>Recommends a better tool during interaction</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Accepts tool improvement suggestion from team member</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>416</td>
<td>Recognizes unacceptable use</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

Dealing with existing tools, had two main aspects: 1) drawing focus to existing tools (codes 93, 124, and 417) and 2) reconfiguring existing tools (codes 379, 319, and 420) (Table 16). Along with introducing new tools, these two primary actions for changing the technology structure in a VT were very prevalent in the data. There were some incidents in which neither of these actions occurred. Those incidents focused more on fitting the people and tasks to the existing tools and motivating better use.

Training and persuading, had two aspects: 1) persuading team members to use (codes 96, 63, 129, 92, and 158) and 2) training team members to use (codes 501, 135, 502, 60, 427, and
This action category seems to represent the intrinsic aspect of motivating appropriation. Persuading and improving team members’ knowledge through training, both get at intrinsic reasons for members to appropriate technology. Improved team member knowledge can also be seen as a people structure change in that the people structure includes the cognitive understanding of technology and the individual knowledge resources of team members. Thus, this category has both appropriation and the people structure as targets depending on what sub-category the action takes as a focus.

Initializing team interaction included a number of actions that involved setting up and designing team interaction. These actions involved taking initial steps that merge the lower-level changes with team interaction behavioral needs to get ICTs used in new ways. It was very prevalent and had aspects of using changes in all three of the structures. Its three aspects were: 1) setting up a tool (code 438), 2) choosing a tool with future team interaction needs in mind (codes 89 and 88), and 3) simplifying tool use complexity (codes 86, 87, and 430) (Table 16). There may be little a VT leader can do about externals to a team interfering in team interaction but react. However, given the prevalence of the tool inadequacy trigger, setting up tools made sense as a potentially proactive technology structure change solution to reduce and possibly member knowledge problems.

Setting and enforcing rules had three aspects: 1) applying pressure (codes 133, 26, and 435), 2) setting rules (codes 320, 332, and 76), and 3) confronting violations (codes 61 and 36) (Table 16). This category provides a counterpoint to training and persuading in that applying pressure and confronting violations all have to do with extrinsic motivation to appropriate technology. Setting rules is extrinsic in nature too but deals more with changing the people
structure with regard to using technology. So, like training and persuading, this action has two possible targets: appropriation and the people structure.

Monitoring interaction had two aspects: 1) troubleshooting (codes 146, 419, and 13) and 2) recognizing problems (codes 415 and 416) (Table 16). These on-going monitoring actions find support in literature on effective leadership of teams (Hackman 2002). They also fit with AST as a type of appropriation action. They are a subset of appropriation actions that do not focus on changing structure but on analyzing the process of structural change in order to drive it and select further actions.

Two major categories emerged as corollary structure change actions. The first aspect appears to address the interference of group structure trigger by changing the task structure, and the second tackles the problem of having to deal with so many inadequate ICTs (median 12.5) in a virtual team in combination with possible problems from member knowledge by changing the technology structure in consideration of the people structure.

Rearranging people dealt with: 1) redistributing authority or responsibility (codes 159 and 43) and 2) changing team members’ physical locations (codes 423, 337, and 410) (Table 16). We found this second aspect ironic. Many companies choose to operate projects in VTs in order to save money. Moving people to reduce virtuality often meant higher costs incurred according to leaders who experienced these incidents, such as in incidents I34P3C3 or I26P2C2 (Table 11), even though cost-saving was likely a reason a project was being carried out in a virtual team in the first place. It seemed clearly preferable in these cases that the ICT come to work rather than that the people be physically relocated.
Modifying tasks had two aspects: 1) rearranging tasks (codes 412, 411, and 413) and 2) assigning new tasks to team members (code 84) (Table 16). This action category was the least prevalent, perhaps because tasks were constrained in the projects due to client contracts.

Per the conceptual model, we analyzed the eight action categories to see if we could see any pattern with regard to project stages (Figure 2). Two main categories emerged: 1) actions more likely to occur initially during the early stages and 2) actions more likely to occur during the middle or production stage (Table 17). There did not seem to be a distinct category of actions that occurs during the late or termination stage.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Dealing with existing tools</th>
<th>Introducing new tools</th>
<th>Training and persuading</th>
<th>Initializing team interaction</th>
<th>Setting and enforcing rules</th>
<th>Monitoring and awareness</th>
<th>Rearranging people</th>
<th>Modifying tasks</th>
<th>Number of Actions</th>
<th>Percent of Total Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up</td>
<td>19%</td>
<td>15%</td>
<td>11%</td>
<td>9%</td>
<td>11%</td>
<td>14%</td>
<td>28%</td>
<td>6%</td>
<td>111</td>
<td>15%</td>
</tr>
<tr>
<td>Early</td>
<td>20%</td>
<td>29%</td>
<td>22%</td>
<td>41%</td>
<td>9%</td>
<td>10%</td>
<td>18%</td>
<td>13%</td>
<td>175</td>
<td>23%</td>
</tr>
<tr>
<td>Middle</td>
<td>46%</td>
<td>49%</td>
<td>58%</td>
<td>34%</td>
<td>65%</td>
<td>63%</td>
<td>37%</td>
<td>75%</td>
<td>372</td>
<td>49%</td>
</tr>
<tr>
<td>Late</td>
<td>15%</td>
<td>7%</td>
<td>10%</td>
<td>15%</td>
<td>15%</td>
<td>14%</td>
<td>18%</td>
<td>6%</td>
<td>95</td>
<td>13%</td>
</tr>
</tbody>
</table>
We expected the early actions might include setting up and designing interaction as well as introducing new tools. The data did show this relationship, especially when one considers the early and start-up stages together as the orientation stage. Doing so, initializing team interaction had 50% of its occurrences in orientation and introducing new tools had 44%. Likewise, dealing with existing tools (39%) and rearranging people (46%) showed up as common orientation stage actions (Table 17). While introducing new tools did have a strong tendencies toward the orientation stage, we were surprised to see a large number of new tool introduction actions occurring during the middle stage (49%). We interpret this as an indication of the volatility of virtual teams and on-going needs to improve interaction even if new tools need to be introduced.

The middle stage or production actions include the remaining actions. The largest portion of the technology facilitation actions occurred during in the middle of the projects (372 of the 753 actions sampled, 49%).

The action categories weights displayed some interesting variance (Table 14). Modifying tasks had a relatively low weight of 46.79, showing it to be relatively rare as an action in our sample. Does this mean modifying tasks is difficult or generally not considered an option by virtual team leaders? Given that virtual teams often face tightly controlled tasks with tight schedules, predetermined deliverables contractually promised to external clients, and other task constraints, we expect part of the lack of prevalence of modifying tasks actions relates to the predominance of externals to the team interfering as a trigger. If tasks are constrained as a structure in the team, the virtual team leader must choose other change levers.

Modifying tasks did show a strong affinity to occurrence in the middle of a project. This makes sense given the escalation or commitment literature on IS development projects. This literature suggests it is only after a critical mass of problems occur related to the central task(s)
that a team will make substantial changes to the task(s), whether escalating or de-escalating their commitment (Keil 1995; Montealegre et al. 2000).

4.7 Categorization of Changes

Five categories of structural changes from technology facilitation emerged (Table 18). These categories represent what happened in team interaction as a result of a virtual team leader’s technology facilitation actions. They displayed a broad representation of the interviews and incident data discovered in the study with at least eight discrete interviews represented in each category. The judges did not discover any higher order pattern among the changes.

<table>
<thead>
<tr>
<th>Structural Change Type</th>
<th>Change Dimension</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-level</td>
<td>Existing tool use</td>
<td>13</td>
<td>26</td>
<td>83.33</td>
</tr>
<tr>
<td></td>
<td>Using new tools</td>
<td>11</td>
<td>23</td>
<td>71.15</td>
</tr>
<tr>
<td></td>
<td>Task</td>
<td>8</td>
<td>12</td>
<td>48.72</td>
</tr>
<tr>
<td>High-level</td>
<td>Participation</td>
<td>13</td>
<td>28</td>
<td>84.62</td>
</tr>
<tr>
<td></td>
<td>Information processing capacity</td>
<td>8</td>
<td>15</td>
<td>50.64</td>
</tr>
</tbody>
</table>

There was no guarantee that a structural change would take place in a critical incident. In four incidents there was no structural change. A tool was neither added nor removed, task or
people structures did not change, or a new tool failed leaving no change. In these four incidents where there was no change at all, the technology facilitations therein were deemed failures by the interviewees. Where changes did occur, the five categories apply.

The most prevalent structural changes were changes in participation with a high weight value of 84.62 (Table 19). The participation and information processing theme codes were difficult to subdivide. As a structural category, participation did not exist in the original conceptual framework, and it was unclear exactly what to make of this late-comer. It had elements of team interaction needs being met as well as changes to the group-level organization of the people structure. It appeared that participation was actually some sort of hybrid higher-level structure that occurs as a result of prior or lower-level structural changes.

Considering participation as a higher-level structure, it could be divided into three aspects: 1) coordination changes, those changes that impacted timing of exchange or ability to structure work flows and interdependencies (codes 258, 41, 74, and 372), 2) cooperation changes, those changes that changed the willingness of team members to interact (codes 66, 17, 301, 348, and 394), and 3) communication changes, those changes that influenced members’ ability to transmit messages between each other if they had transmittable information (codes 371, 253, 32, and 10) (Table 19). The coordination changes focused primarily on people structure changes at the team level, organizing people to interact, grouping them one way or another, and similar changes. The cooperation and communication changes had more of an impact or outcome aspect. They seemed to indicate more or a higher-level change in which a team interaction need was met in addition to simply changing a structure.

We elicited data on structural changes that resulted from technology facilitation actions by asking the interviewees, “What evidence do you have of some change in the team’s
technology use due to your action(s)? What did you hear or see or feel?” (Appendix G). These questions gathered a range of responses including lower-level ones that simply told which ICTs began to be used for what specific tasks, new and existing ICTs and corollary task impacts, and higher-level responses that told the impact of the changed ICT use on team interaction, specifically participation and information processing (Table 18). Taken together, these responses expose a hierarchy of structural changes. This hierarchy implies that the use of an ICT must filter through the higher-levels in order to be of value to a virtual team. If it does not enable participation and information processing, it is useless. We saw this effect in several incidents where the ICT got installed and nominally used, such as I25P1C1, I29P2C3, and I31P2C3 (Table 11).

Table 19: Analysis of Change Dimensions

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>139</td>
<td>Expands use of existing tool(s)</td>
<td>54.49</td>
<td>9</td>
<td>13</td>
<td>25%</td>
</tr>
<tr>
<td>259</td>
<td>Increased synchronous tool use</td>
<td>23.72</td>
<td>4</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>486</td>
<td>Tightly controlled tool use instituted</td>
<td>17.95</td>
<td>3</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>103</td>
<td>Easier tool used instead of difficult, problematic tool</td>
<td>17.31</td>
<td>3</td>
<td>3</td>
<td>6%</td>
</tr>
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<td>Incidents</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>-----------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>344</td>
<td>344</td>
<td>New features added to existing tool and used</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>Changed way team used existing tool(s)</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>Balance struck between FtF and virtual benefits</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>137</td>
<td>137</td>
<td>Existing (comfort) tool(s) failed</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>260</td>
<td>260</td>
<td>Increased voice tool usage</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
</tbody>
</table>

**Using new tools**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>345</td>
<td>345</td>
<td>New tool added and change in task use</td>
<td>59.62</td>
<td>10</td>
<td>77%</td>
<td>13</td>
</tr>
<tr>
<td>347</td>
<td>347</td>
<td>New tool becomes embedded, applied beyond initial scope</td>
<td>35.26</td>
<td>6</td>
<td>46%</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>Added one or more communication channels (redundancy increase)</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
</tr>
<tr>
<td>344</td>
<td>344</td>
<td>New features added to existing tool and used</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>387</td>
<td>387</td>
<td>Policy change enabled tool addition/ use (organizational)</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>349</td>
<td>349</td>
<td>New tool failed</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>350</td>
<td>350</td>
<td>New tool had a bandwidth requirement</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
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<td>Incidents</td>
<td>Quotations</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>disabling some participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>352</td>
<td>New tool interfered with task</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td></td>
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<td>2%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>353</td>
<td>New tool only partially added due to</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>technical problems for some</td>
<td></td>
<td></td>
<td></td>
<td>2%</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>458</td>
<td>Task automated in tool</td>
<td>18.59</td>
<td>3</td>
<td>23%</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
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<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>459</td>
<td>Task change accompanied by tool change</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6%</td>
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<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>346</td>
<td>New tool added but no change in task use</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4%</td>
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<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>254</td>
<td>Increased ability to get whole task done at</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>once</td>
<td></td>
<td></td>
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<td>2%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>496</td>
<td>Tool enabled more tasks to be handled at</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td></td>
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<tr>
<td></td>
<td>once</td>
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<td>2</td>
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<tr>
<td><strong>Participation</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>258</td>
<td>Increased structured participation</td>
<td>35.9</td>
<td>6</td>
<td>46%</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>15%</td>
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<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>257</td>
<td>Increased participation</td>
<td>30.13</td>
<td>5</td>
<td>38%</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
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<td></td>
<td></td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Centralized shared information resource</td>
<td>29.49</td>
<td>5</td>
<td>38%</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Cooperation improvements</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>371</td>
<td>Participation of critical member enabled</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Created authoritative information source</td>
<td>23.08</td>
<td>4</td>
<td>31%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8%</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>and archive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Additional group participation through changed tool use</td>
<td>17.95</td>
<td>3</td>
<td>23%</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>253</td>
<td>Increased ability to contact team members</td>
<td>17.95</td>
<td>3</td>
<td>23%</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>32</td>
<td>Better information access and control for one group</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>10</td>
<td>Ability for larger group to participate</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>301</td>
<td>Leader relocated self to weak group to increase virtual communication</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>348</td>
<td>New tool enables socializing</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>354</td>
<td>New virtual participation better than old FtF way</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>372</td>
<td>Participation structured around subgroups to filter information</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>394</td>
<td>Problem member begins to use tool appropriately</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Information processing capacity**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>Increased information/process visibility</td>
<td>35.9</td>
<td>6</td>
<td>46%</td>
<td>8</td>
</tr>
</tbody>
</table>
Changes in existing tool use were also very prevalent. They appeared in two ways: 1) existing tool use expanded or reduced (codes 139, 259, 486, 344, 42, and 260) and 2) one existing tool’s use was exchanged for another’s use (codes 103 and 29) (Table 19). These changes were very specific to the ICTs already existing in the team’s toolkit and how they were being used prior to and after the facilitation. As a category they correspond with the actions focused on dealing with existing tools and suggest that there are specific classes of actions and changes that one can target when attempting to deal with existing tools.
New tool use changes, similar to the existing tool use changes, corresponded to an action category, introducing new tools. Changes in new tool use ranged from a new tool being added and used, perhaps embedded so deeply that it gets used beyond its initial scope, to policy and permissions changes corollary to using new tools. This category provided a logical counterbalance to changes in existing tool use. Changes in using new tools also had two aspects: 1) actually using a new tool (codes 345, 347, 16, and 349) and 2) new tools and team structures interacting (codes 387, 350, 352, and 353) (Table 19). The interaction of new tools and team structures offers some insight into the complexity of technology facilitation. Introducing an ICT may be an opportunity for improving team interaction, but using new tools may also conflict with existing participation, organizational context, or task structures, causing a need for corollary structural change actions or additional appropriation actions.

Information processing capacity changes provided a second higher-level category of changes. They were also difficult to sub-categorize, not having been present in the original conceptual framework. They appeared to have three aspects: 1) changes in information visibility (codes 256 and 11), 2) changes in information manipulability (codes 255 and 456), and 2) changes in information exchangeability (codes 33, 34, and 254) (Table 19). Changes in the information processing structure or capacity have a higher-level view than changes in existing tool use, for example, in that they imply an operational interaction need, information processing, that was changed as a result of lower-level changes, such as changes in existing tool use. Information processing changes seemed to fit with participation changes. Participation makes sense as the mechanism of team interaction with information processing as its goal. Though they may not be structural changes, strictly speaking, they were important and relevant based on the
judges’ consensus. However, information processing capacity changes were not very prevalent, with a weight of 50.64.

Task changes were the least prevalent. They had two aspects: 1) task automation in a tool (code 458) and 2) changes in ability to multi-task (codes 254 and 496) (Table 19). Task changes accompany technology changes in existing and new tool use to form the three lower-level change categories.

Curiously, there was no people structure change category though “people” is clearly one of the core structural input categories in the conceptual model (Figure 2). The judges did not have access to the conceptual model or research design in making the categories. It seems that the people changes were folded into participation. It’s coordination sub-category ended up with codes referring to relocated team members, changes in ability for people to contact each other, and inter-grouping changes. The technology facilitation actions categories also displayed a bias toward treating the people structure differently than task and technology in that people structure changes got grouped into the two motivation-oriented appropriation actions.

The change categories showed a hierarchy that fits the flow of our conceptual framework from input structures to team interaction. Lower-level or initial, concrete changes in task and technology provided a basis for changes in group participation and the ability to process information and do work. These might be represented graphically (Figure 6). While these relationships seem plausible based on the data collected, they also reflect on the IS literature regarding technology use and group performance. At base, there is a task and technology link, which relies on certain people structures too. Provided the use at the base level changes, the interaction among team members can change, leading to better participation and information processing capacity.
Questions on structure change were the most difficult for the interviewees to answer, perhaps because of the difficulty of distinguishing these levels of structure change and how they are differentiated from outcomes. As a result, answers ranged broadly. Adaptive structuration theory already posits that structures have multiple levels, the physical-objective and the cognitive-subjective. Perhaps the difficulty we found is indicative of this divide such that participation and information processing capacity changes involve the cognitive-subjective structures more so than the existing and new tools and task changes. As a result, these different sorts of changes would probably require different questions during the interview.

There was some variation in the prevalence weights among the structural change categories. Task changes had a very low weight of 48.72. Given the difficulty of taking task actions, discussed in the actions analysis, it made sense that there were few task changes. The existing tool use and participation change categories showed substantial prevalence with weights of 83.33 and 84.62, respectively. Both occurred in incidents of all thirteen leaders.
Participation, in particular, seemed important as a differentiator between having a substantial impact on team interaction and just implementing new technologies, policies, or roles. One interviewee noted (I30P2C2):

D: What was your evidence of some change in technology use? It sounds like you had immediate feedback from some people.

L: Yes, I would say the increased participation, which ultimately shortens the turnaround, the number of emails that you need to send out to everybody to get the right things done. While before I would have made the change while people are talking... Now I’m making changes or not just me, everybody on the team had ownership of different parts of the deck… Then within a couple of minutes it’s resolved as opposed to being within a matter of four or five emails between three, four, or five people.

This leader certainly was able to implement a new technology, e-meetings for co-editing documents. However, it was only through the use of that new technology in the process of editing that higher-level structural change was felt. This is the participation change. More members could input feedback immediately and changes could be confirmed and accepted by consensus or challenged without additional days spent emailing and discussing. These are communication and coordination improvements.

4.8 Categorization of Outcomes

The analysis produced ten categories of outcomes (Table 20). The outcomes fell into three categories: people, process, and project. Four of the individual outcomes showed low to very low levels of prevalence according to our weight statistic, but each of the three larger categories had at least one outcome with a high weight. The four outcomes with the high
weights, in order, were time, information, project completion and quality, and trust and morale. These four outcomes get at the heart of technology facilitation and why it is important. Improved use of ICTs in VTs can save time by improving efficiency, improve information processing accuracy and quality, lead to higher-quality products delivered on time, and encourage better interpersonal relations among team members. Each of these outcomes has been noted in the IS literature as a key necessity in either VT projects or IS development work. Successful technology facilitation provides one means to achieve these outcomes.

Table 20: Technology Facilitation Outcomes

<table>
<thead>
<tr>
<th>Outcome Dimension Type</th>
<th>Outcome Dimension</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>People</td>
<td>Trust and morale</td>
<td>12</td>
<td>26</td>
<td>78.21</td>
</tr>
<tr>
<td></td>
<td>Accountability</td>
<td>8</td>
<td>11</td>
<td>48.08</td>
</tr>
<tr>
<td></td>
<td>Learning</td>
<td>7</td>
<td>8</td>
<td>41.03</td>
</tr>
<tr>
<td>Process</td>
<td>Time</td>
<td>12</td>
<td>40</td>
<td>87.18</td>
</tr>
<tr>
<td></td>
<td>Information</td>
<td>13</td>
<td>31</td>
<td>86.54</td>
</tr>
<tr>
<td></td>
<td>Communication</td>
<td>10</td>
<td>17</td>
<td>62.18</td>
</tr>
<tr>
<td></td>
<td>Participation</td>
<td>9</td>
<td>14</td>
<td>55.13</td>
</tr>
<tr>
<td>Project</td>
<td>Project completion and quality</td>
<td>13</td>
<td>31</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Money</td>
<td>6</td>
<td>9</td>
<td>36.54</td>
</tr>
<tr>
<td></td>
<td>Client satisfaction</td>
<td>4</td>
<td>4</td>
<td>23.08</td>
</tr>
</tbody>
</table>
The people and process outcomes had substantial overlap with the participation and information processing structural outcomes. As mentioned in Chapter 3, we had made a decision in framing this study, that we would split the outcomes category of a prior, similar study’s design in order to be sure to meet the needs of applying AST, that is, to ensure that we could isolate structural changes separately from the impact structural changes had on work. We believe clarifying this divide proved challenging during the interviews, and as a result, the respondents had some trouble figuring out where the line was between structural changes and the team outcomes.

The first people outcome was trust and morale. This outcome had two aspects: 1) relationships (codes 426, 505, 368, and 504) and 2) emotional states (codes 334, 335, 336, 149, 295, 122, 150, and 453) (Table 21). Relationships outcomes of technology facilitation can be critical enablers of productivity, as in this example from I23P1C1:

L: They’ve become much more amenable to what we’re trying to do since we’ve reached out to them in this teleconference. And, I think that this team, the QDB team that I’m managing now is probably one of the only teams that does this, but it’s one of the only teams that delivers on time and on budget.

Emotional states outcomes can also be important. They may unlock frozen morale, enabling productivity boosts. Here’s an example from I30P1C1:

If there was a reward, it was sort of a sense of relief. Basically, relief is a bad word in a sense, because people did not feel good. But, there was this growing unspoken tension. Every time I spoke to someone one-to-one, this was a failure. This was not going to complete. Everything was wrong. I would get these great confidences from these people one-to-one. These guys would just open up. I
think that everybody from the senior managers to the - well, I didn’t necessarily talk one-to-one with the developers, because there was the time thing- but even some of the offshore individuals, there was this need to talk to someone about how bad things were going. But, this was not going to work. Therefore, I think that even against people’s will in some cases, when we started imposing the more method to the whole thing, I think in general people thought that this was starting to change and it was a good thing to participate in all this, if only to show that they were not part of the problem. “Oh look. I’m reporting, and I’m doing this.”

### Table 21: Analysis of Outcome Dimensions

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<tr>
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<tr>
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<td>improved</td>
<td></td>
<td></td>
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<tr>
<td>334</td>
<td>Morale declined</td>
<td>28.85</td>
<td>5</td>
<td>38%</td>
<td>5</td>
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<tr>
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<td>Trust between groups improved</td>
<td>24.36</td>
<td>4</td>
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<tr>
<td>335</td>
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<td>3</td>
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<tr>
<td>336</td>
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<tr>
<td>149</td>
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<tr>
<td>295</td>
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**Accountability**

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**Learning**

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**Information**

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**Communication**

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<td>29.49</td>
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<tr>
<td>300</td>
<td>Leader promoted to enable change</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>81</td>
<td>Deadline for delivery missed</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>251</td>
<td>Inaccuracies impact next project/phase</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>252</td>
<td>Incomplete deliverables</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>397</td>
<td>Product delivered incomplete</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>398</td>
<td>Product delivered on time</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>400</td>
<td>Product quality declined</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>460</td>
<td>Task fully accomplished</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Money**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>487</td>
<td>Time and money saved</td>
<td>23.72</td>
<td>4</td>
<td>31%</td>
<td>5</td>
</tr>
<tr>
<td>72</td>
<td>Cost overrun avoided</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>37</td>
<td>Budget exceeded</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>73</td>
<td>Costs escalated</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>
## Accountability covers group and individual levels

Here, accountability refers to the ability to monitor progress of individuals or groups and hold them to their contracts or the work they are assigned. We did not find clear sub-themes within accountability. Here is an example of accountability as an outcome in I35P2C2 as a result of establishing a shared project status document in a public space:

L: The whiteboard mentality serves two purposes. First, you see it. You can’t escape it. The other thing is it’s dynamic. You can change things and visually see how things change very quickly. It takes some of the emotional intelligence out of it by putting it in a public space. It adds some pressure, especially if everybody on the team is kicking butt and Sally-Sue is behind. It’s a little incentive to her to say, “Hmm, I’m the only one behind” or for project management to say, “why is Sally-Sue behind, or maybe the work was misestimated, or she needs additional support, or there’s a dependency that hasn’t...
been fulfilled.” And it’s not buried in some Microsoft document. It’s boom. It’s right there.

Learning is another people outcome. It occurred in three levels, individual (code 314), team (codes 311 and 313), and organizational (code 312), that agreed with our conceptual framework’s (Figure 2) proposition that there would be these three levels possible as a people outcome (Table 21). This people outcome, unlike the other two, did not seem to overlap with a structural change category. It offered one surprise. Organizational policies may change as a result of learning due to a virtual team’s technology facilitation episodes. This contradicts prior research on virtual teams that found organizational structure unchangeable relative to a virtual team’s appropriation actions (Majchrzak et al. 2000). It seems likely to us that such change is rare, and we only found it due to the unique critical incidents approach taken in this study. This approach allowed us to sample a large number of technology adaptations in-depth and focus directly on the process of technology adaptation through a technology facilitation lens.

The four process outcomes substantially overlapped the higher-level structural outcomes, with communication, information, and participation explicitly showing up in both places and the time outcome mapping closely to participation’s coordination sub-category. Time formed the most prevalent process outcome with two aspects: 1) coordination and efficiency (codes 104, 493, 70, 106, 68, 69, 67, 95, and 107) and 2) avoidance of pitfalls (codes 432, 444, 443, 433, 105, 305, 441, and 489) (Table 21). Information had two outcome sub-categories: 1) exchange (codes 274, 281, 262, 268, 275, 277, 273, 272, and 276) and 2) quality (codes 280, 264, 278, 82, 263, 265, 266, 267, and 279) (Table 21). Communication had three aspects as an outcome: 1) quality (codes 58, 369, 370, 54, 57, and 321), 2) efficiency (codes 59 and 56), and 3) ease (code 55) (Table 21). Participation as an outcome did not directly display sub-categories, though
cooperation showed up (Table 21), mirroring the structural change participation and one of its sub-categories (Table 19).

The project outcomes dealt with the main deliverables promised by the project. The first project outcome was project completion and quality, which focused on two goals: 1) enabling project progress (codes 128, 125, 126, 127, 80, 404, 81, 252, and 398) and 2) improving product quality (codes 401, 396, 399, 397, 400, and 460) (Table 21). This was a very prevalent project outcome category. Enabling project progress agreed with findings in a prior study of virtual team members and the core goals of virtual team leadership (Thomas et al. 2005b). Technology facilitation can be a mechanism for achieving this goal.

Money came next and covered additional costs incurred or avoided. Surprisingly, money was not very prevalent, and time did not show up explicitly as a project outcome; however, we reasoned that time became money at the end of a project, so that money outcomes were the end-of-project incarnation of time outcomes in the process.

Client satisfaction included increases and declines in client satisfaction in general, reductions in client fear, and improvements in client confidence (Table 21). The low number of theme codes in client satisfaction and their low weights caused us to forego attempts at subdividing major themes within client satisfaction. Like client satisfaction, we did not subdivide money into themes. The three project categories made sense as a set in that several leaders reported almost exactly these three categories when asked what the metrics of success were in their projects.

Four of the outcome categories found strong prevalence in the incidents and interviews—trust and morale, information, time, and project completion and quality—, but client satisfaction, money, accountability, and learning were low. Accountability and client satisfaction were not
found universally by all judges and have questionable support but were deemed important by the judges and retained. Accountability showed little consistency across the judges’ independent sortings. The client satisfaction codes, on the other hand, had a lot of agreement among the judges, but had low weights due to only appearing on one incident and interview each for a total of four interviews and incidents represented by the client satisfaction category. While this is not as high as the other categories, the judges felt the category had strong enough evidence and importance to keep it. Money and learning showed up in the judges sortings but were not very prevalent. In money’s case, that may be due to other factors compensating. For example, one code under the time outcome reads “time and money saved” (code 487) (Table 21). Several leaders repeated the old mantra “time is money” during the interviews. Perhaps, the time outcome with the highest weight score and many codes masks money savings, causing the prevalence of the money outcome to go down.

We believe learning was less prevalent in the data, though important and powerful when present. Thus, it seems reasonable that learning would have a low weight.

4.9 Categorization of Beliefs

We handled the beliefs analysis a bit differently than the triggers, actions, changes, and outcomes, because the beliefs were largely unique to individual interviewees and, therefore, few showed up in multiple interviews or incidents, making prevalence a moot point (see incident and interview counts as well as weight statistics in Table 23, Table 24, Table 25, and Table 26). The number of beliefs theme codes was also much larger than the other categories due to the unconstrained nature of the beliefs category. Interviewees volunteered many general observations on various aspects of technology facilitation that were classified as beliefs. So, we looked for strong patterns among the judges’ independent sortings of the beliefs, as we did for
the other categories, but we did not try to use the weight prevalence statistics. We found patterns among the four judges’ sortings. The dominant categories that emerged were beliefs on appropriation (Table 23), being a virtual team leader (Table 24), people and team (Table 25), and specific ICTs (Table 26). Within these four major beliefs categories we identified sub-themes (Table 22).

Table 22: Virtual Team Technology Facilitator Beliefs

<table>
<thead>
<tr>
<th>Belief Dimension Type</th>
<th>Belief</th>
<th>Dimension</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appropriation</strong></td>
<td>Training</td>
<td>5</td>
<td>38%</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Individual differences</td>
<td>4</td>
<td>31%</td>
<td>5</td>
<td>10%</td>
<td>23.72</td>
</tr>
<tr>
<td>Motivation</td>
<td>4</td>
<td>31%</td>
<td>5</td>
<td>10%</td>
<td>23.72</td>
</tr>
<tr>
<td>Technology ease of use</td>
<td>3</td>
<td>23%</td>
<td>6</td>
<td>12%</td>
<td>19.23</td>
</tr>
<tr>
<td><strong>Being a VT leader</strong></td>
<td>Attitude</td>
<td>10</td>
<td>77%</td>
<td>15</td>
<td>29%</td>
</tr>
<tr>
<td>Team and project management</td>
<td>7</td>
<td>54%</td>
<td>9</td>
<td>17%</td>
<td>41.67</td>
</tr>
<tr>
<td><strong>People and team</strong></td>
<td>Team size</td>
<td>5</td>
<td>38%</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Staff</td>
<td>3</td>
<td>23%</td>
<td>4</td>
<td>8%</td>
<td>17.95</td>
</tr>
<tr>
<td>Clients</td>
<td>3</td>
<td>23%</td>
<td>3</td>
<td>6%</td>
<td>17.31</td>
</tr>
<tr>
<td>Organizational culture</td>
<td>2</td>
<td>15%</td>
<td>3</td>
<td>6%</td>
<td>12.18</td>
</tr>
<tr>
<td>International culture</td>
<td>2</td>
<td>15%</td>
<td>2</td>
<td>4%</td>
<td>11.54</td>
</tr>
<tr>
<td><strong>Specific ICTs</strong></td>
<td>Technology contingencies*</td>
<td>8</td>
<td>62%</td>
<td>11</td>
<td>21%</td>
</tr>
<tr>
<td>Belief Dimension</td>
<td>Type</td>
<td>Belief Dimension</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Weight</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
<td>------------------</td>
<td>------------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Email</td>
<td></td>
<td>Face-to-face</td>
<td>7</td>
<td>7</td>
<td>40.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instant messaging</td>
<td>5</td>
<td>6</td>
<td>29.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project management software</td>
<td>3</td>
<td>4</td>
<td>17.95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-meetings</td>
<td>3</td>
<td>3</td>
<td>17.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Telephone</td>
<td>2</td>
<td>2</td>
<td>11.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cell phones</td>
<td>1</td>
<td>1</td>
<td>6.41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Email repositories</td>
<td>1</td>
<td>1</td>
<td>5.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>File transfer protocol</td>
<td>1</td>
<td>1</td>
<td>5.77</td>
</tr>
</tbody>
</table>

* This dimension contains a variety of theme codes from the other specific ICT dimensions and a few new ones that refer to contingencies of when to use specific ICTs.

The VT leaders’ beliefs provide a glimpse of their mental models of technology facilitation (Table 22). Reflecting on the conceptual framework, we can see that VT leaders have categories of ideas that relate to several pieces of the technology facilitation process but not all. They think about the people structure and the technology structure and the relationships between the people, task, and technology structure, but they apparently have few thoughts about the task structure. There were a few task structure beliefs. For example, one mentioned that distributed development being different from in-house and another emphasized the importance of
using different testing and debugging techniques when developing a real-time system. However, it seemed that most VT leaders took the task as a given and focused more on other elements of technology facilitation. Though they exist as such, these two codes did not make the cut as task codes in the final analysis. For example, the distributed development code (code 97) ended up under the staff sub-category of the people and team beliefs (Table 25).

A successful VT leader thinks about technology appropriation (Table 23). Within appropriation he holds beliefs on individual differences among team members, motivation, the ease of using technology, and training. The individual differences among team members include beliefs about which factors take precedent over others like cultural issues superceding technical issues. Motivation gets at how to get team members to change. Several motivation beliefs focus on showing the benefits of ICT whether through letting team members get burned or telling them up front. These align with the training and persuading appropriation actions that were the most prevalent appropriation actions in the data. Beliefs about technology ease of use emphasize simplifying and taking advantage of ICTs team members will already know. The presence of these beliefs underlies the proposition that successful VT leaders try to avoid labeling problems as “user error.” Rather, they seem to accept the levels of member knowledge available and use other levers to facilitate better technology use when possible.
<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual differences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Cultural and technical axes differentiate team members' ICT use tendencies.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>233</td>
<td>ICT may be left or right brained and a personal fit with user leads to more successful appropriation.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>292</td>
<td>Latent ICT knowledge among team members leads to improvement suggestions during interaction.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>476</td>
<td>Techies will know more ICTs than non-techies.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>477</td>
<td>Technical issues are easier to solve than cultural issues.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td><strong>Motivation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>ICT used for personal and business purposes is easier to add.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>235</td>
<td>If immediate project team can't see need, it's harder to get them to appropriate ICT.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Let them get burned - motivates appropriation but costs time and possibly more grave consequences.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>374</td>
<td>People may appropriate new technology simply</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
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<td>------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>375</td>
<td>People may appropriate technology if they believe it really would be more efficient.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>378</td>
<td>Personal preference drives choice.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>442</td>
<td>Show benefits when adding an ICT.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>445</td>
<td>Some ICT changes are to support future needs that are invisible to the immediate project team.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Technology ease of use**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>A tool's internal business logic can disable work if cumbersome.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>51</td>
<td>Comfort technologies - email, system access, phone - are easily appropriated.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>163</td>
<td>Have an immediate technology that allows you to share visuals / screens.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>308</td>
<td>Learning curves drive ICT choice. If it's too hard, it doesn't get chosen.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>316</td>
<td>Live demonstrations enable understanding new systems best.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>390</td>
<td>Present a mock-up for design work... don't begin with a blank slate question.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>436</td>
<td>Screen sharing is useful for demonstrating developing capabilities or form.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>437</td>
<td>Security and functionality must be balanced in ICT choice and implementation: they’re opposed.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>440</td>
<td>Shared ICT toolkit serves as resource for coordinating technology change later if needed.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>446</td>
<td>Some ICT is generally appropriated: requires no training, little technical attention.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>447</td>
<td>Some ICT is not generally appropriated: requires technical attention.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

### Training

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>Demonstrated need leads to use and agreement to use.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>98</td>
<td>Do initial technology training on a set of ICTs.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>101</td>
<td>Don't overwhelm people with ICT setup and use requirements.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>157</td>
<td>Get team members to use the ICTs early in the project.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>479</td>
<td>Test your ICTs before using them for production work.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>
The training beliefs corroborate the importance of training and persuading actions and the member knowledge trigger we found. Virtual team members apparently need to be able to conduct training to give them the best chance for success, and according to the beliefs we found, some of that training is explicit and formal, other portions of it have to do with informal, day-to-day actions of the VT leader reminding team members how to use the ICTs, demonstrating the use and usefulness of the ICT during interaction, and getting team members to help each other.

VT leaders hold beliefs about their role and how to fulfill it (Table 24). These beliefs express themselves in terms of what attitudes to take as a VT leader and how to go about team and project management. Within our AST framework, these are beliefs about the leader as appropriation actor, a portion of the people structure in a VT. There were a variety of specific leader identity beliefs within the two subcategories (Table 24). Virtual team leaders need to sense and see the overall picture of what is happening in the project and represent it to the team through virtual means. They serve as filters or controls on information production and flow. They must be very sensitive to a project’s status and the working relationships among interdependent co-workers. If they fail to deal with conflicts and problems as they arise, they may not see them again until they critically damage the project.
### Table 24: Beliefs about Being a Virtual Team Leader

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>Attitude</td>
<td>17.31</td>
<td>3</td>
<td>23%</td>
<td>3</td>
</tr>
<tr>
<td>132</td>
<td>Attitude</td>
<td>12.18</td>
<td>2</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>164</td>
<td>Attitude</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Attitude</td>
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<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>90</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>140</td>
<td>Attitude</td>
<td>5.77</td>
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<td>8%</td>
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<tr>
<td>142</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
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<tr>
<td>285</td>
<td>Attitude</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

- Proper preparation prevents poor performance.
- Err on the side of too much information sharing. - let people filter it out.
- Have empathy.
- A good leader monitors mistakes and analyzes them.
- A good leader proactively tries new technologies to learn about them.
- Be sensitive about high-jacking a project.
- Believe your client when confronted.
- Develop co-worker relations - not just "professional".
- Experience leads to knowledge about what pays off procedurally and commitment to sometimes tedious uses of technology.
- Facilitating technology use saves time. And, time is money.
- It's better to deal with conflict when it surfaces.
<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td>306</td>
<td>Leaders can motivate appropriation through force of personality.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>315</td>
<td>Listen and take good notes in an accessible format.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>452</td>
<td>Stay calm and try to understand when issues arise.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>483</td>
<td>There’s always a solution.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>503</td>
<td>Treat all deliverables equally - art must be on time just like code.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Team and project management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A &quot;task manager&quot; does not keep things whole like a &quot;project manager.&quot;</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>27</td>
<td>Archive text messages as much as possible.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>46</td>
<td>Client and team leader should be collocated for primary interactions.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>83</td>
<td>Delegate technology facilitation if personally don't know about it.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>102</td>
<td>Don't release control of project plan.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>155</td>
<td>Get involved early. Be proactive.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>307</td>
<td>Leaders must know project status, even if failing.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>
Many expressed the need for the VT leader to have a positive attitude. Codes along this line reported beliefs like, “have empathy” (code 164), “believe your client” (code 31), “there is always a solution” (code 483), “stay calm and try to understand” (code 452), or “develop co-worker relations” (code 90) (Table 24).

VT leaders hold beliefs about people and teams (Table 25). These beliefs focus on how aspects of the people structure figure into being a VT leader and facilitating technology use. They include beliefs on organizational and international culture, on clients and relationships with
them, on staff, and on team size. Some considered international and organizational culture factors during technology facilitation. These beliefs can be very specific, such as Asian members may hesitate to communicate openly in emails. Europeans may want to socialize more before getting straight to the point. Some organizations have their own use norms for ICT, and these can disable certain options during project work. This does not mean VT leaders should always accommodate organizational use norms, in several cases leaders changed the norms. One implemented a new teamroom ICT. Another got organizational policy changed to allow instant messaging then trained the members. Beliefs about clients impact VT leader technology facilitation thinking too, especially in consulting relationships, where it seems a VT leader profits from having domain knowledge and developing the relationship with the client. VT leaders facilitated technology use change to build these relationships using instant messaging in at least two cases.

Table 25: Beliefs about People and Team

<table>
<thead>
<tr>
<th>Code ID</th>
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<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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<tbody>
<tr>
<td>31</td>
<td>Believe your client when confronted.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>46</td>
<td>Client and team leader should be collocated for primary interactions.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>90</td>
<td>Develop co-worker relations - not just</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>&quot;professional&quot;.</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
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<td>--------</td>
<td>------------</td>
<td>----------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>91</td>
<td></td>
<td>Developing a personal relationship with the client builds trust.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>99</td>
<td></td>
<td>Don't cave in to client demands. Validate them.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>166</td>
<td></td>
<td>Having domain knowledge of client's business builds trust.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>249</td>
<td></td>
<td>In order to build trust as a consultant, be a real person - not a stereotypical consultant.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
</tr>
</tbody>
</table>

**International culture**

<table>
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<tr>
<th>Code ID</th>
<th>Theme Code</th>
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<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td>24</td>
<td></td>
<td>Americans are very blunt.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>78</td>
<td></td>
<td>Cultural and language barriers supercede technology issues.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>110</td>
<td>Email between Asia and US is problematic.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>136</td>
<td>Europeans want some socializing.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>465</td>
<td>Team members from Asia and Europe are resistant to criticizing.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>466</td>
<td>Team members from the Asia-Pacific area need to see sincerity.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
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</table>

**Organizational culture**

<table>
<thead>
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<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td>153</td>
<td>FtF is critical during formation to setup personal</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>364</td>
<td>Organizational culture may dissuade information sharing.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>365</td>
<td>Organizational culture norms about ICT use can lead to problems.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>367</td>
<td>Outsourcing requires corporate sponsorship - commitment to no going back.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>Distributed development skills are different from in-house.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>232</td>
<td>ICT does not change personal core volition / motivation to work.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>310</td>
<td>Legacy staff don't favor outsourcing - be ready with change management strategies.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>390</td>
<td>Present a mock-up for design work... don't begin with a blank slate question.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>485</td>
<td>Tie legacy staff performance to whole engagement performance in outsourcing.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Team size</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

172
<table>
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<tr>
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<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Big teams begin at about 12-15 members. Less than that is a small in terms of ICT use issues.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>101</td>
<td>Don't overwhelm people with ICT setup and use requirements.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>123</td>
<td>E-Meetings are better for larger, more disperse teams.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>148</td>
<td>For large systems, in the long term compiling information about the setup process is critical.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>152</td>
<td>FtF is costly, but in larger, more critical projects, it mitigates risk.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>290</td>
<td>Large projects need orientations to &quot;level the playing field&quot;.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>291</td>
<td>Larger projects benefit from more structure.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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</tbody>
</table>

VT leaders showed beliefs about the specific needs of virtual team members or staff. The skills for distributed development, the core volition to work, and legacy staff involvement in outsourcing were all considered. Team size also drew attention. Apparently, larger teams need more structure and can benefit more from the more complex ICTs.

There was a large number of beliefs that focused on specific ICTs and the contingencies for their successful use in a VT (Table 26). These are beliefs about the technology structure and
its interactions. This is the bulk of technology structure knowledge that had been referenced in
the triggers as leader knowledge and in the actions as necessary for leaders to introduce new
tools or deal with existing tools among other actions. Successful VT leaders think about a wide
variety of ICTs and how they can be effective.

Table 26: Beliefs about Specific Information and Communication Technologies

<table>
<thead>
<tr>
<th>Code ID</th>
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<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td><strong>Cell phones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Cell phone reception is unreliable.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>Cell phones are unreliable, batteries die.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td><strong>Email</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>Email always has problems.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>109</td>
<td>Email and PowerPoint are good enough for small-team synchronous meetings.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>110</td>
<td>Email between Asia and US is problematic.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>111</td>
<td>Email is inappropriate for immediate issues involving cross-group discussion.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>112</td>
<td>Email is more adequate in small teams.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>113</td>
<td>Email is too slow for immediate discussion because concentration</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
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<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
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<td>---------</td>
<td>------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>114</td>
<td>Email is very reliable but not so quick like the phone.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>480</td>
<td>Text can be misconstrued easily.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
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**Email repositories**

<table>
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<th>Code ID</th>
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<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>Email repositories help build organizational learning capability.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>118</td>
<td>Email repositories increase accountability and message commitment.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>119</td>
<td>Email repositories lead to improved ability to cope with turnover.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>2%</td>
</tr>
</tbody>
</table>

**E-meetings**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
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<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>A combined media (textual-visual-audio) presentation boosts retention for new material.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>123</td>
<td>E-Meetings are better for larger, more disperse teams.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>2%</td>
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</tbody>
</table>

**Face-to-face**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
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<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>151</td>
<td>FtF enhances focus and demeanor more than phone.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>46</td>
<td>Client and team leader should be collocated for primary interactions.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>53</td>
<td>Communicate face to face, if possible, body language drives understanding.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>152</td>
<td>FtF is costly, but in larger, more critical projects, it mitigates risk.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>153</td>
<td>FtF is critical during formation to setup personal dynamics if overcoming organizational culture differences.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
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**File transfer protocol**

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<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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</thead>
<tbody>
<tr>
<td>154</td>
<td>FTP is better with small teams or few people using it.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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</table>

**Instant messaging**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>244</td>
<td>IM is like a virtual water cooler: socializing device.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>245</td>
<td>IM is no good for long, complex discussion.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>246</td>
<td>IM makes people more accessible.</td>
<td>6.41</td>
<td>1</td>
<td>8%</td>
<td>2</td>
</tr>
<tr>
<td>237</td>
<td>IM allowed playfulness due to custom of allowing spelling mistakes: improved intra-team relations.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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<tr>
<td>238</td>
<td>IM can intrude if forgotten (not turned off during a presentation).</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
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<td>Incidents</td>
<td>Quotations</td>
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<td>---------------------------------------------------------------------------</td>
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<tr>
<td>239</td>
<td>IM can stop the virtual team ripple effect by enabling reaching decision-makers with simple requests.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>240</td>
<td>IM can work like a Post-it note on screen.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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<tr>
<td>241</td>
<td>IM does not help ensure reflection - too quick.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>242</td>
<td>IM is better than phone for quick questions.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>243</td>
<td>IM is good for a quick attention grab.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
</tbody>
</table>

**Project management software**

<table>
<thead>
<tr>
<th>Code ID</th>
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<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
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<tr>
<td>6</td>
<td>A project management tool must handle details on the personal level well.</td>
<td>5.77</td>
<td>1</td>
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<tr>
<td>100</td>
<td>Don't let project management ICT get in the way (especially too sophisticated is unnecessary.)</td>
<td>5.77</td>
<td>1</td>
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<tr>
<td>325</td>
<td>Microsoft Project helps create a common ground for coordination.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>326</td>
<td>Microsoft Project is good for high-level project management.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>327</td>
<td>Microsoft Project is time-intensive to use.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>329</td>
<td>Microsoft Project is useful for very detailed (complex) project plan.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
</tr>
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<td>--------</td>
<td>------------</td>
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<td>------------</td>
</tr>
<tr>
<td>328</td>
<td>Microsoft Project is too complex on low-level.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>151</td>
<td>FtF enhances focus and demeanor more than phone.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>245</td>
<td>IM is no good for long, complex discussion.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>247</td>
<td>Immediate, person-to-person communications are more effective for conflict resolution.</td>
<td>11.54</td>
<td>2</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>A combined media (textual-visual-audio) presentation boosts retention for new material.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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<tr>
<td>109</td>
<td>Email and PowerPoint are good enough for small-team synchronous meetings.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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<tr>
<td>236</td>
<td>If you have a lot of repeat processes, build custom ICTs or features to automate them.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>242</td>
<td>IM is better than phone for quick questions.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>243</td>
<td>IM is good for a quick attention grab.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>316</td>
<td>Live demonstrations enable understanding new systems best.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
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<tr>
<td>380</td>
<td>Phone is better than IM for detailed, immediate issues.</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>383</td>
<td>Phone may be unreliable in consulting projects</td>
<td>5.77</td>
<td>1</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Code ID</td>
<td>Theme Code</td>
<td>Weight</td>
<td>Interviews</td>
<td>Incidents</td>
<td>Quotations</td>
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</tr>
<tr>
<td>409</td>
<td>Real-time systems projects require alternate test techniques than usual.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
</tr>
<tr>
<td>449</td>
<td>Static representation is second best way to relay understanding of new system concept – after live demonstration.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
</tr>
<tr>
<td>478</td>
<td>Teleconferencing and chat work better than email alone in design tasks.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>2</td>
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</table>

**Telephone**

<table>
<thead>
<tr>
<th>Code ID</th>
<th>Theme Code</th>
<th>Weight</th>
<th>Interviews</th>
<th>Incidents</th>
<th>Quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td>Phone is better than IM for detailed, immediate issues.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
</tr>
<tr>
<td>381</td>
<td>Phone lacks structure necessary to ensure a process flow - such as strategy then discussion.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>2</td>
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<tr>
<td>382</td>
<td>Phone may be inaccessible, require a code.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
</tr>
<tr>
<td>383</td>
<td>Phone may be unreliable in consulting projects due to unpredictable host office accommodations.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
</tr>
<tr>
<td>384</td>
<td>Phone may not be physically available.</td>
<td>5.77</td>
<td>1 8%</td>
<td>1 2%</td>
<td>1</td>
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</tbody>
</table>
As a recurring theme from the leader knowledge trigger and the need for ICT knowledge in actions, such as introducing new tools and dealing with existing tools, many of the VT leaders had very specific opinions about the characteristics and usefulness of the phone, email, project management software, or instant messaging. One pointed out that the phone is not fully reliable or available in many cases. Others said the phone does provide a means for better conflict resolution than email, IM, or other asynchronous means. Email seems to be a liability in large groups or longer-term projects, especially when new members enter. In such cases, email does a poor job of encapsulating lessons and knowledge and representing it for easy retrieval for the new-comers. Project management software, particularly Microsoft Project, received multiple criticisms for its inability to handle the daily task level well. It was praised for its supple high-level view. Instant messaging had several comments too. It seems to be a new means for socializing virtually. Perhaps it is a casual cousin or hybrid of email and the phone. With this casual nature comes risk. One new user failed to turn it off and had an embarrassing message pop-up during a presentation to clients.

One subcategory within the beliefs on specific ICTs focuses on technology contingencies. Many of these beliefs are also listed under individual ICT categories. For example, “IM is better than the phone for quick questions” (code 242) is listed under the Instant Messaging sub-category as well as the Technology Contingencies sub-category. We pulled out the Technology Contingencies sub-category because it showed up in three judges’ sortings, and it has a focus on the relationships between the various ICTs, relationships we wanted to inspect during the ad hoc analysis.

Some of these relationships seem to conflict. For example, “phone is better than IM for detailed, immediate issues” (code 380) seems to conflict with code 242 mentioned above. In the
other individual subcategories there also other conflicts. In Project Management Software, one belief reads, “Microsoft Project is too complex on low-level” (code 328) while another reads “Microsoft Project is useful for very detailed (complex) project plan” (code 329).

We expect that within individual sub-categories the individual preferences of the VT leaders and their own beliefs begin to show. Thus, we believe the categories of beliefs are valid and provide a basis for future research into VT leaders’ mental models of technology facilitation, but we do not claim that the specific beliefs are representative of the correct stance a leader should take. If there are one or more such correct stances, that would be a topic for future research to resolve. This study found that there are specific areas in which successful VT leaders hold beliefs with regard to technology facilitation.

4.10 Analysis of Key Input Relationships Between Structures

The input structures, technology, task, and people, could each have a direct relationship with team interaction and, therefore, technology appropriation. They may also have interactive relationships with each other according to our conceptualization (Figure 2). In the process of data collection and analysis we found some basis to comment on the two interactive relationships.

4.10.1 Task and Technology Interaction and Technology Appropriation

The relationship between task and technology structures showed up in across the progression of critical incident categories though it seemed weakly represented. Only in the changes category did it show up as a discrete category. In the triggers, tasks and technology were a primary cause of technology facilitation when externals to the team interfered. Triggering interactions between task and technology took the form of task constraints on time or
the schedule. Organizational policies and upper management intrusions also figured into this task-technology interaction. As a whole, the relationship appeared one of task constraints being imposed on the VT leader, causing the VT leader to take action.

In the actions, leaders took actions to modify tasks, but these were the least prevalent of the actions categories by a substantial margin. It seems that modifying tasks is not an action that VT leaders frequently take, perhaps because the tasks are constrained external to the VT leader’s realm of power and control as indicated in the trigger externals to the team interfere. Task did figure into the initializing actions. In that case, it makes sense that a VT leader considers the constraints imposed by the task on team interaction and makes technology choices accordingly.

Direct changes to task structure in the process of technology facilitation did appear in the structural changes. The three low-level changes, dealing with existing tools, introducing new tools, and task, indicated that initial structural changes from technology facilitation targeted the task and technology link. Task figured prominently in the outcomes, represented in the process and project outcomes, but there was little indication of information about how these related to task interaction with technology.

In the beliefs, there were some comments on the interaction of task and technology, especially in terms of work types. For new design work, it seems VTs need to have a synchronous presentation system that allows screen sharing with simultaneous voice. For real-time systems projects, there seems to be a lack of adequate tools for dispersed development work. Debuggers don’t work because invoking them influences the system, and remote real-time system testing and full control access is often not given for security reasons.
4.10.2 People and Technology Interaction and Technology Appropriation

The people structure had a very prominent role across the five critical incident categories. It also showed up in relation to technology in each. Two of the trigger categories involved the relationship between people and technology structures. These were interference of group structure and member knowledge. They represent the two levels of the people structure, collective or team and individual or team member. In these triggers, collective issues like team size, team dispersion, and team demographics interacted with technology structures, and individual issues like members being able to operate an ICT but not effectively or members lacking knowledge or experience to be able to operate an ICT. In terms of the physical dispersion of members and the size of the team, it seems the more disperse the team, the more they needed to have some kind of socializing ICT, such as instant messaging. Teams above 12 to 15 members seem to undergo a transition in which ICTs such as fancier eMeeting technologies and group support technologies like shared team rooms and structured messaging systems become more useful. At smaller sizes, many of the “comfort ICTs” like phone and email seem more adequate.

The leader knowledge trigger also took technology and people into account. Leaders took into account the specific people in his virtual team and how they preferred to use ICT. This personal ICT preference among members came up as a critical consideration in technology appropriation when leaders were choosing what to do during technology facilitation. Leaders reported considering “comfort” ICTs in their technology facilitation decisions. They would consider who knew how to use what and then adjust their facilitation appropriately. This does not mean that they would automatically chose a “comfort” ICT. Rather, if they were choosing a
“non-comfort” ICT, such as a new team room tool or complex, new development support tool, successful leaders would bring together the members and hold a re-orientation training session.

The people-technology relationship carried over into the actions in the appropriation actions of training and persuading and setting and enforcing rules actions as well as corollary structuring actions that directly rearranged people in order to enable a technology facilitation. It appeared that in order to motivate the appropriation process, corollary people structure changes were needed, such as setting or redefining ICT usage rules that would impact the objective (group structure) people structures or implementing new training that would impact the cognitive (member knowledge) people structures.

In the structural changes, curiously, the people structure did not appear as a low-level or initial structural change of technology facilitation even though several of the actions had focused on people structure change in relation to technology. The people structure changes did show up in participation changes to coordination structures that integrated the group level of people using technology.

The outcomes displayed an entire type including three outcomes devoted to people-technology interaction. These outcomes included accountability, learning, and trust and morale. It appears that changes in technology use can impact the efficacy of people structures as both carrots and sticks, trust and accountability. The learning outcome reversed the relationship. People took knowledge from their experience of technology use change and reapplied it at individual, team, and organizational levels in other contexts to improve the efficacy of technology structures.
4.11 Summary

This chapter presented the main findings of this study. It described the 13 VT leaders sampled, the 30 projects they reported and the ICTs used in those projects, and the 52 critical incidents found. Latter sections presented the main deliverables of this research project that specifically answer the research questions. These sections described how the deliverables were put together, including a unique weight statistic derived to help judge the prevalence of the individual dimensions and theme codes found and how the deliverables sections relate to the adaptive structuration theory (AST) base underlying the study. Then they presented detailed analysis of the five critical incident categories and the dimensions identified within them: 1) triggers (6 dimensions with 2 types), 2) actions (8 dimensions with 3 types), 3) changes (5 dimensions with 2 levels), 4) outcomes (10 dimensions with 3 types), and 5) beliefs (21 dimensions with 4 types). A final section presented an ad hoc analysis of the relationships between technology and the people and task structures.
CHAPTER 5: CONCLUSIONS AND IMPLICATIONS

“I’ve been working in computers for years, and only the simplest stuff works 90% of the time.” – a virtual team leader reflecting on technology facilitation

5.0 Chapter Overview

We set out to answer three research questions with six deliverables (Table 2). Those deliverables have been developed through careful, empirical research using virtual team leaders in the field and presented in Chapter 4. In the process of developing those deliverables and in reflecting on them, we collected a number of findings with implications for both researchers and practitioners. Those findings and their implications are discussed in this final chapter. The first five sections discuss the combined findings regarding technology facilitation, presenting nine propositions. The next section reports discussion of findings related to theory, research methodology, and the current contexts of VT projects. Implications for researchers, VT practitioners, and ICT developers follow. Limitations of this study are reported last.

5.1 Combined Findings Model

Figure 7 shows the combined findings of this study regarding technology facilitation triggers, leader actions, structural changes, team outcomes, and leader beliefs and knowledge. The elements of this model derive from the specific deliverables- categorizations- produced and presented in chapter four as direct answers to the three fundamental research questions driving this study:

1) What structural triggers lead to VT leader technology facilitation?

2) How do VT leaders facilitate technology use?

3) What impact can technology facilitation have?
This section overviews the findings as presented in Figure 7. The following sections discuss each component of Figure 7 in detail and explain its derivation from the findings in chapter four.

Figure 7: Study Findings

Leader knowledge and beliefs are shown as the base of this model because they drive the entire process. VT leaders engage in monitoring actions throughout the team interaction process. These monitoring actions identify structural opportunities and problems with regard to information and communication technologies (ICTs). Following trigger identifications, VT
leaders take actions to cause structural changes. The oval shaded area in the center of the model shows the structuring process as leader actions that result in emergent structures. Structures are the rules and resources that constrain and enable team member behavior.

Leaders may directly manipulate technology, task, and people structures, and they may take supporting actions that promote appropriation of the existing or newly manipulated structures. In one case (I23P1C1, see Appendix K), a leader found problems arising from using email with group members in Asia who were not understanding the messages. To address this communication problem, he changed the work schedule to accommodate a new rule of having synchronous, phone meetings after any major discussion through email and persuaded the Asian team members to follow this rule. He had not added an ICT but emphasized new use of the phone. Relations improved and work became much more productive. In another case (I25P2C2), a leader found the collaboration portal for the team was causing several problems. It had performance and access problems. Information could not be found. He developed a consensus that this tool was inadequate, assigned a team member to research new tools, acquired a new portal software, developed norms for using this new portal, trained the team on it, assigned a member to administer it, and mandated its use. Team interaction improved with the new tool in place, leading to less stress, better morale, more efficiency, improved communication, and better information processing capacity.

The leader’s actions lead to initial, emergent, low-level changes in technology, tasks, and people structures in the team. Over time and possibly with the aid of additional appropriation support actions, these low-level changes lead to higher-level emergent structure changes in participation and information processing capacity. These changes are “higher-level” in that they
presume the use of lower-level structures within team interaction. It is these higher level changes that lead to intermediate and final outcomes.

When successful, technology facilitations resulted in a variety of outcomes including saving troubled projects, making budgets, innovating company processes, higher quality products, and higher client satisfaction (Figure 7). In one case (I30P1C1), the leader came into an ailing project involving multiple organizations, some off-shore. The previous leader could not handle the senior staff in the other organizations. The new leader spent time assessing the situation, realizing there were tool inadequacies (email could not handle their messaging needs), information visibility problems (shared task information could not be accessed easily), internal group structure problems (dispersion and team size made email unworkable as the main information sharing device), and cooperation problems (private communications between members that should have been shared and differing views on task information led to conflicts).

His primary technology change was centralizing all of the task information in an Excel spreadsheet and placing that spreadsheet in a shared teamspace where all members could view it any time and update their portions. He also set some new rules and engaged in persuasion actions to encourage open communication using the new structure. He attributed this seemingly simple solution with resolving the conflicting data trouble and resultant cooperation problems, improving members’ accountability to each other, improving morale, and saving the project from failure. As he put it, “the business would have pulled the plug… although this was very strategic,… there comes a time when there is no more option… no more millions to throw at it or no more time.”
5.2 Participation and Information Processing Capacity

Participation and information processing capacity form the core of how the VT leaders in this study viewed team interaction. This was a major finding that helped understand the whole process of VT leader technology facilitation. Therefore, these two pieces, most strongly related to the structural change analysis are being discussed in advance of the remainder of the technology facilitation process so that they may be used to understand what was happening. Though they emerged in the findings regarding structural changes they were also found in team outcomes analysis, and we discuss that derivation here too.

An examination of the structural changes (Table 18) and team outcomes (Table 20) from technology facilitation revealed the presence of participation and information processing capacity in both. Participation figured prominently in both the higher-order changes and the team process outcomes. Information processing capacity changes and information outcomes matched too. The “communication” outcome was part of the participation structural change, and some aspects of the “time” outcome could be seen in the coordination aspect of participation as well as savings due to better cooperation in the structural change participation. Thus, we merged the overlapping portion of the structural change and team outcome categories into the higher-order emergent structure categories.

The structural changes presented themselves as changes to specific, objective technology and task structures initially and secondarily as changes to higher-order phenomena that presume a team interaction function, such as participation and information processing capacity. We did not expect this differentiation, though it makes some sense in terms of AST. DeSanctis and Poole discussed the “structural potential” of ICTs in framing AST (p.127, 1994b). Structuring potential refers to the spirit and features of an ICT that a team can use to generate social
structures. Having the ICT installed and available creates this structural potential in a group. In the same sense, having the low-level emergent structural changes equates to having a new structural potential. Unlike the low-level emergent structures, participation and information processing changes require ICT use in team interaction. Team interaction requires social activity, and since the social activity is presumably emergent and new to the team, it equates to the realized structural potential noted in AST. Therefore, these higher-order changes are the realization of change in the social structure of the team.

Participation changes were a dominant, unexpected category. Participation centers on the team members: 1) how they cooperate or express their willingness to work together, 2) how they coordinate information flows or are able to know when to send what, and 3) how they communicate or are able to transmit messages between each other. These sub-categories of participation provide an interesting starting point for future research into the nature and effectiveness of VT participation. They have each been studied in prior research and deemed important in team interaction. This study identified their coherence as elements of participation. For example, a large literature exists discussing the role of coordination relative to ICTs in group interaction (Argyres 1999; Espinosa et al. 2001; Montoya-Weiss et al. 2001; Tan et al. 1999). Communicative capacity in relation to ICTs in virtual group work has also received substantial attention (Dennis et al. 1999; Scott 1999) as had cooperation, especially in relation to inter-organizational virtual group settings (Bensaou 1997; Jarvenpaa et al. 1999; von Krogh et al. 1996).

Information processing capacity also emerged as a dominant, unexpected category. Information processing has been a dominant theme studied at the organizational level within IS research for a long time (Galbraith 1974; Tushman 1978). The aspects of information processing
capacity found in this study were at the team level and included information visibility, manipulability, and information exchangeability. Information processing capacity centers on the information at the core of virtual work: 1) visibility or having accurate, accessible information in shared information repositories, 2) manipulability or having information that can be jointly visualized and manipulated simultaneously by dispersed team members, such as jointly rotatable 3-D models or even screen-shared spreadsheets in which members share mouse movement and the ability to do “what-if” analysis, and 3) exchangeability or having information in forms that can easily transfer intact virtually from member to member.

These three aspects of information processing capacity make sense as particular challenges and needs in virtual teams, and they have been largely ignored, especially as a set of characteristics of information processing capacity at the team level. Individually, they have received some attention, especially in the group support systems and knowledge management literatures. For instance, studies have looked at the impact of differing levels of meta-knowledge and richness in exchangeability (Dennis et al. 2003; Kirkman et al. 2004a), manipulability in terms of graphical versus textual (Dennis et al. 1998), and visibility in management or building shared understanding (Collins 1997; Malhotra et al. 2004; Nicholson et al. 2004).

Many leaders reported problems with members “going dark” or choosing not to respond and, thereby, being invisible. Physical choices by members not to respond have more to do with earlier changes in member relations, but the leaders also reported similar issues in which information went dark too. It was not findable or it could not be represented in common or it could not be manipulated by multiple members. Problems also emphasized the ability to get a piece of information into and through an ICT pipe in a form that would be useful on the other end. Information processing capacity problems of this sort frequently occurred in the data.
The data indicates that higher-level changes are critical. In some cases, lower-level changes did occur, but higher-level changes did not occur, as in I25P1C1 and I27P2C3, and the leaders deemed these incidents failures. Thus, we postulate:

**P1: To have a positive impact on outcomes, technology facilitation must achieve high-level changes in participation or information processing capacity.**

The definition of structural changes as they relate to technology facilitation and technology appropriation has had little attention in current literature, particularly these higher-level changes and what relationships there are among them. Based on the data, it seems there is no guarantee that if lower-level changes occur higher-level changes will follow, if our presumption of lower and higher levels among the change categories is correct. This is an area for future appropriation research that could benefit from the methods developed in this study. Future studies could apply AST and CIT in order to isolate process chains that occur during technology facilitation incidents using the dimensionalized root categorizations from this study. They could then explore sequential, process relationships, such as those we have posited among the structural changes. Such relationships could include sequencing leader actions to examine technology facilitation effectiveness and how to best deal with various possible contingencies.

**5.3 Impact of Technology Facilitation on Project Outcomes**

The examination of project outcomes told us that technology facilitation can have a critical impact on a project’s product as well as its process of working. We found ten categories of outcomes from technology facilitation, three impacting the product, three impacting the people, and four impacting the team interaction process. The project outcomes covered the three commonly reported answers to our question, “For managing your project, what were your
internal metrics or indicators of project status and success?” (Appendix I). These three were
money, project completion and quality, and client satisfaction (Table 20). At its most critical
level, interviewees reported that technology facilitation saved projects from failure, enabling
project completion, saving money, and improving client satisfaction. On the flip side, failure to
successfully facilitate technology use when problems arise could lead to project failure. This
critical role for technology facilitation points to the value of this study.

From the people perspective, there were a number of additional possible outcomes from
technology facilitation. One surprising finding was that technology facilitation within a virtual
team’s project can lead to organizational learning and change, as was the case in incidents
I34P1C1 and I35P3C4. This finding was surprising in that prior research on technology
appropriation in virtual teams had suggested that the organizational level would not change in
response to a team’s actions (Majchrzak et al. 2000). It seems organizational change in response
to a team’s interaction and learning is rare, and we were able to find it only because we had a
large sample of technology appropriation incidents to inspect. Aside from learning, people
outcomes occurred in accountability and trust and morale.

Nevertheless, organizations can benefit from technology facilitation, not only by saving
failing projects and improving outcomes of already-successful project, but also by learning how
to better implement virtual team projects in the future. In fact, eleven of the thirteen leaders
interviewed (85%) reported being used as “fixers” by their firms. Their firms recognized a
special capability in them to save troubled projects. The data suggest that part of this ability
relates to their ability to facilitate technology use in virtual teams. Their firms did recognize
them, even though the interviewees did not report being explicitly trained in technology
facilitation. Thus, we postulate that:
P2: Organizations that recognize and promote the VT leader’s technology facilitation role will have more successful virtual teams.

5.4 Recognizing Triggers

When do VT leaders decide to facilitate technology use in their teams? What makes them decide to act? These questions drove our inquiry into the structural triggers that lead a VT leader to initiate technology facilitation. Presumably, understanding the triggers can help identify occasions when technology facilitation is appropriate and ways in which VT leaders can better setup their VTs to avoid the need for reactive technology facilitation when problems occur.

Structural triggers of technology appropriation have two sources as far as virtual team leader technology facilitation is concerned: opportunities and problems (Table 13, Figure 7). The first source is more proactive in nature and relies on leader knowledge of ICTs and how they might be used in the virtual team. The triggers imply a role for VT leaders that requires monitoring and some creativity, as they involve problems and opportunities. Only 12 of the 52 (23%) technology facilitation critical incidents collected had an opportunity focus; the general attitude we found was “if it’s not broken, don’t fix it.” Leaders focused on problem triggers much more than opportunities. Note that in many problem-focused incidents several of these problems occurred simultaneously.

Opportunity triggers rely on leader knowledge. The VT leader conceives of ways to improve participation or information processing capacity within the team by changing the ICTs being used or the ways in which one or more ICTs is being used. In one incident (I26P1C1), a leader got the team to acquire and install an eMeeting tool that enabled a critical client meeting to include the larger team without overwhelming the client. This was a large success and
required training and pilot-testing the new ICT mid-project. Such opportunities can lead to improvements in participation or information processing capacity while avoiding the breakdowns in team interaction that define problem triggers.

We expected that leader knowledge and the use of opportunities to improve team interaction through technology facilitation would show a bias toward more-experienced and successful VT leaders. This bias would result from their being able to better manage the daily tasks of technology facilitation and recognize opportunities quickly, acting before problems develop. This was the case in several opportunity-driven incidents including I22P3C4, I25P3C4, I26P1C1, I29P1C1, and others (see incident summaries in Appendix K).

The problem triggers spring directly from the input structures we originally positioned to the left of team interaction, namely task, technology, and people (Figure 2, see Chapter 2). The five problem-sourced triggers are externals to the team, interference of the group structure, lack of training and tool use problems, an ICT being inadequate, and trust and relationship breakdowns between team members. This last trigger surprised us. It seems trust and interpersonal relations can directly impact technology appropriation without any consideration for the technology input structure. We expected that any appropriation effect would have to occur in relation to technology from the start or it would not be relevant to technology appropriation, but this was not the case with trust triggers. As in incidents I22P2C2, I26P2C2 and I27P1C2, failure of relations between the team members led to failure of team interaction, and consequently, ICTs could not be effective.

Essentially, trust and relationships are aspects of the people structure. Thus, the people structure can directly short-circuit team interaction, causing technology appropriation to fail as a by-product when trust and relationships between team members sour. This finding agrees with
prior virtual team research on the importance of trust (Jarvenpaa et al. 1999). Once member relationships are addressed, technology appropriation can take place, as in I26P2C2. It appears then that trust among the team members is a necessary precursor for technology appropriation.

P3: If trust and relationship breakdown triggers are present, technology facilitation will only be successful once these triggers are successfully addressed.

As for the other problem triggers, they match with literature on team development and leadership. The team’s size, relative mix of cultures and organizations represented among the team members, and dispersion matter. The organizational policies governing the team and any restrictions on schedule and budget matter. The level of training and experience individual team members have with ICTs matters.

The actual features of ICTs are often inadequate and matter. ICT designers should take a note from this last finding. Many of the ICTs including simple, standard ones like the phone and email showed substantial feature inadequacies in this study. Issues like file transfer in email and phone reliability and ability to capture and archive messages remain issues for future design to resolve. They also showed a tendency enlightened by AST. Per AST, ICTs have a spirit which captures the consensus about the values and goals of a given ICT or, put another way, the status quo of how to use an ICT (DeSanctis et al. 1994b). This status quo exists within groups such as organizations and national cultures by consensus. This consensus stabilizes over time as the ICTs get used, such that new ICTs will have more conflicting interpretations of how to use them.

In the virtual teams we studied, team members came from multiple organizations and multiple national cultures. With the most “comfortable” ICTs (particularly email), we found that the stable consensus on spirit within organizations or national cultures was actually different
across organizations or cultures and led to very confusing and unexpected trust and relationship breakdown conflicts as in incidents I23P1C1 and I27P1C1. This is an excellent opportunity for virtual team leaders to effectively use explicit, upfront technology facilitation through training to build a shared understanding of even the most comfortable technologies, especially in the more globally and organizationally dispersed teams.

**P4: In globally and organizationally dispersed virtual teams, upfront technology facilitation training to build consensus on goals and values of the most comfortable technologies, such as email, will lead to fewer trust and relationship breakdowns.**

Other than trust and member relations’ direct relationship with team interaction, the triggers involved technology. Externals to the team interfering involves task and organizational components imposed on the team in combination with technology. Interference of group structure occurs when task design choices internal to the team and technology do not agree. Member knowledge problems occur when the team members have inadequate knowledge of or experience with the technology, and when a tool is inadequate, technology alone is the cause of failed team interaction. We had posited each of these relationships conceptually based on our literature review. Trust and member relationship breakdowns was one exception. Our findings support our conceptualization, and we can see in the literature post hoc where trust and member relations becomes a major issue in virtual team interaction.

**5.4.1 Technology Inadequacies**

Technology inadequacies and use problems do occur. There was a high prevalence of tool inadequacy problems and externals to the team interfering in team interaction in ways that led to changed ICT needs. The technology inadequacies provide substantial support for the
premise that it is not trivial to integrate socio and technical systems in advanced ICTs (DeSanctis et al. 1994b). Their prevalence suggests that ICT companies have much work to do to make technology full-featured and capable of adapting to the needs of the users. So, we can imagine that an ICT may actually have a feature, but if the users don’t know about it or how to use it, the feature essentially does not exist from their standpoint. At such times, ICT may be designed to suggest its features or reconfigure itself to accommodate the users. While such a reconfiguration or adaptation presumes some built-in user training and needs sensing capability, it is already built into some software packages, take for example the helper in Microsoft Word ’97 or later asking if you need help writing a letter. As ICTs mature, they can improve technology appropriation directly by successfully implementing technology facilitation features.

Some of the most intensive efforts of the larger software companies continually focus on integration and technology facilitation efforts that would presumably make tools more simple and supple for virtual interaction. The most prominent current example may be Microsoft’s efforts to put all of it’s communication tools into one tool labeled Office Communicator 2005. They have been working on this integration for years and have yet to succeed. This problem gets complicated when one considers that real VTs are using 12 to 13 different ICTs in each project, and many of the versions of their individual ICTs are not inter-operable. There is clearly a need for increased ICT design research efforts and research into how to balance and simplify the use of ICT to avoid tool inadequacies. It is within the team leader’s purview in most cases to change or manipulate the ICTs that his team uses, introducing new tools or dealing with existing ones. Leaders need to be made aware of this and of the high potential that the tools they have been given may be inadequate.
5.4.2 How ICTs Become Inadequate

Exactly what makes a tool inadequate structurally offers another line for inquiry. In and of itself, many ICTs displayed technical problems that made them unreliable or unavailable. They also had bandwidth and capacity issues. These sorts of issues appeared in a number of incidents, displaying tool inadequacies. Much research has been conducted on and is being conducted on the technical side of tool inadequacy in the computer science field. On the social-people side of tool inadequacy, human-computer interaction and information scientists have also offered many insights and continue to conduct many studies. It would make an interesting study to integrate the findings of these fields and other IS research around tool inadequacy.

Some research has looked at fits between tools and tasks in terms of tool adequacy. This may be where the “task” trigger went, since the judges did not explicitly identify one. We found some evidence of a direct relationship between tasks and technology appropriation. In some cases, tasks got automated in ICTs leading to extensive use and effectiveness, and some leaders reported specific beliefs about which ICTs are appropriate to tackle certain tasks. Nevertheless, it seems task was often constrained and often became relevant as a constraint on technology use in the virtual team projects we studied. As a result, the action category, modifying tasks, was the least prevalent. This sample presumed a virtual team in a fairly controlled task sample, IS development projects. If these controls were relaxed, we might see other ways in which the task and technology relationship makes tools inadequate or otherwise surfaces as a trigger.

5.4.3 The People Structure and Technology Facilitation Triggers

Three of the trigger categories drew from people structure issues-interference of group structure, member knowledge, and trust and relationship breakdowns, and a fourth, leader
knowledge, may also be considered an issue of the people structure represented by the leader. These categories account for four of the six trigger categories and a majority of the triggers. We interpret this importance of the people structure as confirmation that socio-technical systems problems remain an issue partly because practitioners and researchers continue to fail to consider the people part of systems success fully (Bostrom et al. 1977a; Bostrom et al. 1977b).

Researchers should look more at how team input structures, especially people, fit with specific technologies. Some of the leaders offered specific beliefs on people and technology. They thought email and Asia-American culture mixes on teams would have a high likelihood of problems or legacy staff put into an outsourcing arrangement would refuse to cooperate using asynchronous communications virtually unless forced on a dictated schedule. Future research should look into what other people-technology interactions can cause a tool to be inadequate.

5.4.4 Outside Interference in Virtual Team Affairs

Externals to the team interfering presented a different sort of problem than tool inadequacies in that a team does not have the option of controlling and manipulating items external to it in most cases. These triggers impose constraints like project schedules, organizational policies on access to systems and permissions, and upper management intrusions. In one case, a former lower-level VT leader was promoted and immediately changed the permissions policy of his organization in order to enable one of his VTs (incident I35P3C4). As we learn more about VT appropriation and technology use needs, issues related to externals to the team interfering should become clearer and policy makers should be able to make more changes that reduce external interference and enable better ICT use and team interaction in their VTs. These factors are also a subject fit for future research.

5.5 Leader Knowledge and Beliefs and Their Role
Ultimately, what makes a VT leader decide to facilitate technology use depends on the VT leader’s knowledge and beliefs. Even when a problem occurs, a VT leader must use his knowledge and decide to act (Figure 7). The data suggest technology facilitation will not begin from a problem trigger without this interaction of a problem trigger with leader knowledge. The successful VT leaders we sampled believe that technology facilitation is important and has made critical differences in projects they have led, often enabling project completion, monetary savings, and improvements in the quality of the product or service delivered. These beliefs motivate a VT leader to act. Our inquiry turned to exactly what knowledge a VT leader needs in order to act successfully.

We examined the VT leaders’ beliefs to try and understand what knowledge they had and what they thought about in the role of technology facilitator. The interviewees espoused 135 discrete beliefs about technology facilitation as a virtual team leader. Unfortunately, there was not an opportunity to administer a test to the leaders to more objectively gauge their knowledge, due to time constraints on access to the leaders. As a result, we relied on self-report.

We had carefully screened the study participants to ensure they were experienced, successful VT leaders in IS projects. Successful VT leaders held beliefs in several key areas. These were technology appropriation (Table 24), specific ICTs and their ICT use contingencies in relation to each other and task (Table 26), group structure and team (Table 25), and being a VT leader (Table 24) (Figure 8). We mapped the resulting belief categories to the skeleton of our conceptual framework to search for any gaps or additions. The ovals represent the domain of each area of belief we found (Figure 8).
The beliefs categories covered the conceptual framework, confirming once again that AST was a useful fit for exploring virtual team technology facilitation. The task structure was hard to find in the beliefs at first. In examining the specific beliefs theme codes, we found that task structure beliefs existed. VT leaders expressed beliefs such as how distributed development projects work, needs of real-time systems projects, and how new design work demands certain ICTs for top effectiveness. So, there were task beliefs, but they did not make the cut as an explicit category during the coding and sorting process. Numerically, there were very few of them.
The beliefs on specific ICTs were numerous, and they match the technology structure domain. The beliefs on people and team were also numerous and matched the people structure domain. The technology contingencies beliefs appeared to bridge some of the relationships between structures and relationships between the structures and appropriation. The appropriation beliefs captured team interaction, and some described paths to outcomes. The beliefs on being a VT leader addressed the leader within team interaction. In all, the beliefs did represent the full domain of the conceptual framework. They represent multiple, important aspects of leader knowledge necessary for technology facilitation.

### 5.5.1 Patterns Regarding Leader Knowledge and Technology Facilitation

Prior research about leader emergence in virtual teams suggested that leader ICT knowledge could either be an impediment to successful technology facilitation (Sarker et al. 2002) or might be critical as an enabler (Tyran et al. 2003). We conducted a closer examination to clarify and resolve this issue.

Two larger patterns emerged in the ICT knowledge areas of the beliefs categories map: 1) leader knowledge of discrete, explicit technology structures, such as how to operate the specific ICTs, their contingencies and what will cause them to break, and how complex they are and 2) knowledge of appropriation and team interaction, such as how open members will be to ICT change, what team interaction purpose needs to be served by an ICT change, and what implications and ICT change will have for member relationships. We term the first type of leader ICT knowledge technical ICT knowledge. We refer to the second type as social ICT knowledge.

The data suggest that VT leaders need to have both types of knowledge, but in some incidents, leaders seemed to lack one or the other.
P5: The stronger leaders’ social and technical ICT knowledge the more effective they will be as virtual team technology facilitators.

Lacking one or the other can have implications for which triggers a leader will identify and how they will act. One pattern that emerged involved the ability to discern member knowledge versus tool inadequacy problems. For example, there is a somewhat matched pair of incidents that focused on getting members to appropriate a complex, object-oriented-development support tool mid-project (incidents I27P1C1 and I32P1C4). Both incidents were initially unsuccessful. In the background form, leader I27 showed very strong technical knowledge of ICTs. He has experience programming ICTs and a very technical background. He reported that he has very little interest or capability in dealing with inter-personal issues, though he has had to do so many times (one example is in I27P1C2). Leader I32 has a very strong change management background and status in his firm as a senior partner capable of resolving tough inter-personal issues within projects. Leader I32 admitted that he has little knowledge of how to operate current ICTs.

In I27P1C1 the leader chose a tool that other members could not figure out how to use. Personally, the leader did use the tool and found it very effective in his own work. He was, in fact, a developer of the tool. Trouble setting up the tool led members to frustration and, eventually, abandonment of efforts to use the tool. In I32P1C4 the leader chose a tool that a vendor had promised would solve all of their needs and be easy to setup. Lacking knowledge of the tool, the leader delegated the majority of technology facilitation actions to another team member. That team member proved incapable. Team members began using other ICTs to accomplish the tasks and forming habits around the other tools. Eventually, the leader found a more effective team member to handle the technology facilitation. The delay cost substantially
in terms of several months of project time lost, and the bad habits continued to plague the team and hinder efforts to get the team to move to the new tool. The new tool did not handle the functions the members were accomplishing with their improvised ICT solutions. Though the results of the incidents were similar, how the leaders arrived at those results differed. It seems leader I27 had trouble correctly identifying a member knowledge trigger, and leader I32 had trouble identifying an inadequate tool trigger. These examples point to two sub-propositions within proposition five.

**P5a:** VT leaders who have strong social ICT knowledge but weak technical ICT knowledge will be more likely to miss inadequate tool triggers.

**P5b:** VT leaders who have strong technical ICT knowledge but weak social ICT knowledge will be more likely to miss people-related problem triggers (trust and relationship breakdowns, internal group structure, and member knowledge triggers).

### 5.6 Taking Action

Successful VT leaders are actively involved in setting up and initializing their team’s interaction and in monitoring that team interaction once project work begins (Figure 7). They draw on their knowledge of specific ICTs, their role as VT leaders, how appropriation works, and the nature of people and teams in taking action.

We found eight categories of technology facilitation actions (Table 15). The monitoring actions occur throughout the team interaction process and placed at the bottom of Figure 7 to reflect this pervasive nature. The remaining seven action categories represented two types of actions occurring during the technology facilitation process: 1) direct structural manipulations, actions that installed or reconfigured tools, set new rules, modified schedules, reassigned work
roles or relocated individuals and 2) appropriation support actions, actions that motivated the change process to ensure that it would continue through high-level change. These appropriation support actions showed value not only initially, when most direct structural manipulations occurred, but also, secondarily, once low-level emergent structures were in place, pushing the further emergence of high-level changes.

**P6: VT leaders who supplement structural manipulation actions with appropriation support actions will have a higher likelihood of achieving high-level changes.**

The technology facilitation process actions evidenced some frequency variation by project stage. Introducing new tools and initializing team interaction showed the strongest relationship to early stages in the team while the other actions predominated in the middle or production stages. Interestingly, most actions took place in the middle of team interaction. Several leaders emphasized the importance of reacting quickly when ICT use problem triggers arise. Nevertheless, the tendency of actions toward the middle of the project may expose a reality that leaders often have many other duties to fulfill and technology facilitation often occurs only as the problems become crises. If so, organizations have two choices in virtual team design. They can recognize and promote the leader’s role as a technology facilitator, and they can attempt to get rid of the triggers that lead to the need for technology facilitation. Both options could lead to higher team interaction effectiveness based on better use of ICTs.

The bulk of VT leader actions occurred in the middle of the projects we studied (49%). The combined orientation stage, including start-up and early actions totaled 286 actions (only 38%). We interpret this finding as a renewed call for examining the process of team interaction and how it develops over time. Current research has often looked at deterministic study designs
that relate inputs to outputs skipping intervening processes (Powell et al. 2004). The prevalence of process actions in the field settings we sampled, suggests strongly that future virtual team research and research on appropriation must take intervening processes into account. On this point, our sample’s projects had a median length of 12 months (Table 9). Further, structuring episodes took between a few days and two months for the most part. We can easily imagine that these mid-project actions would be less likely to show themselves in research that sampled short one-semester or shorter student projects as there might not be enough time or complexity for the mid-project effects to develop and not enough impetus to make the investment to change.

Should major problems occur during team interaction, VT leaders may go back and re-setup their team’s interaction in a major revision of structure that involves team interaction. Otherwise, they will typically setup the team interaction up front. The technology facilitation process begins with this initial setup and monitoring its use (Figure 7).

5.6.1 Structural Manipulation Actions

From these initial actions or behaviors, VT leaders gather information about team interaction and the status of technology use and they decide to take technology facilitation actions. These actions focus on directly manipulating structures or supporting appropriation of the manipulated structures. In the data, manipulating the technology structures directly focused on dealing with existing tools or introducing new tools and manipulating the people or task structures to support technology structure changes focused rearranging team members or modifying the team’s tasks. We can imagine that these specific manipulation foci of the direct structural change actions may not be exhaustive and that there may be additional types of direct structure manipulation possible within the three categories or technology, task, and people.
5.6.2 Appropriation Support Actions

Actions such as training members on ICTs, initializing the ICTs in team interaction, enforcing rules and communication policy involving ICTs, and persuading provide support for the appropriation of direct structural manipulations.

Obviously, we expected the technology structure changes to be highly prevalent because we asked the VT leaders what they did in facilitating technology use. We did not expect training and persuading to be the second most prevalent action reported, but it’s prevalence makes sense when we examined the results.

In the case of the persuading aspect, which falls under motivating appropriation, VT leaders often find themselves caught in roles in which they little to no power over team members from other organizations or even other branches within their same organization. As a result, they find it difficult to motivate change/appropriation for such team members by setting rules and enforcing them. They must try other means, typically, training and persuading.

If these means break down, they can try appealing to higher management to set and enforce rules, but this is risky and can result in the leader being removed in a power play, as it did in incident I22P2C3. In this incident, the leader tried to get a “dark” member to participate and use the ICTs, but the member refused. The member’s lack of cooperation was causing the team’s productivity to break down. The leader tried to resolve the issue, but his solution backfired. He then tried escalating the issue to higher management. Direct persuasion actions were forgone in favor of forced compliance actions in this case. This is a common technique in traditional team management and leadership and has been found effective (Dubrin 2004; Hackman 2002).
We found that the more successful leaders are aware of different types of ICT use change and the action options available to them. They seemed to target the three key aspects of appropriation set out in AST: a group’s *faithfulness* in appropriating a technology, a group’s *consensus* on how they have appropriated a technology, and a group’s *attitudes* on how they have appropriated a technology (DeSanctis et al. 1994b). Interestingly, faithfulness, though studied most frequently in the IS literature, seemed less important than consensus and attitudes, especially motivation, in the data. Our data suggest that whether a group appropriates an ICT faithfully with regard to the intent of its use matters less than whether they agree on how it is used and feel positively about using it.

Incident I28P1C3 provides an example of this pattern. The team had high consensus on appropriation and positive attitudes about using the WIKI in this case. Unfaithful use of the WIKI as a joke and socializing tool to the point of inappropriate communications led higher management to take actions. They acted to improve the faithfulness of the team members making the inappropriate posts. Here faithful use of the tool meant using it to exchange information about the programming project they were accomplishing. They had instant messaging and other means for the socializing. This realignment for faithful use was easily accomplished primarily with a simple reminder, which drew on the consensus and attitudes already present.

VT leaders used rule setting and enforcement as well as formal training to push appropriation faithfulness, but they had to use persuasion to create consensus. When an ICT was not being used the same way by two different groups, they ran into large problems, as in the two collaboration portals being used differently in I25P2C2. In that case, the leader persuaded the team to try a third-party, neutral portal, then trained them on how to use it. The incident turned
out very effective, but he had to build consensus before faithfulness. We believe consensus is a key problem in VTs due to their volatility and multi-organizational nature.

P7: VT leaders who emphasize consensus on appropriation and positive appropriation attitudes before appropriation faithfulness will experience greater success in technology facilitation.

The results suggested that virtual settings involving dispersion and multiple organizations make the common, traditional technique of rule-setting and enforcement less effective. It seems the main difference originates in VT leaders’ lack of power to coerce team members through face-to-face influence or through traditional positional power structures. VT leaders need to be able to exercise persuasion through ICTs without relying solely on traditional command and control techniques.

P8: Leaders who rely on persuasion rather than coercion will be more effective in virtual teams.

Training has increased importance in virtual settings too. ICTs are constantly being upgraded and new ones are being added. Meanwhile, the teams are using many of them simultaneously and members from different departments or organizations or cultures will have different preferences and knowledge of ICTs. We found that the teams in our sample were using an astounding median of 12.5 ICTs in their projects. While some of these ICTs overlapped in function and may have been integrated in individual tools, such as chat and instant messaging, most were independent software packages or hardware tools, such as fax.

The more complex ICTs that leaders indicated were more valuable in larger projects, such as the ones we studied, were ICTs like development support tools for object-oriented designing, integrated teamware suites with a variety of functions, and others. Several incidents
focused on the failure of these more complex tools (for example, I25P2C2, I26P2C3, I27P1C1, I28P1C2, and I32P1C4), and training figured in the ones that were more successful (for example, I28P1C1). It appears that team member knowledge must be augmented to use these more complex tools and to motivate or persuade team members to put in the effort to use complex tools. A successful VT leader will not leave learning the complex tools up to the team members.

The shared mental models literature provides some insight on this topic. Shared mental models are critical for effective teamwork when a task is complex as is the case in the VTs studied (Cannon-Bowers et al. 1993; Klimoski et al. 1994). The first model a team must have is that of its technology or equipment; “the dynamics and control of the technology and how it interacts with the input of other team members is particularly crucial for team functioning” (p. 274, Mathieu et al. 2000). ICT is a primary “technology or equipment” in VTs. The equipment/technology shared mental model enables successful ICT use, and one of the best ways to establish it is with training (Thomas et al. 2005a).

P9: All else being equal, VT leaders who conduct training will experience greater technology facilitation success especially when facilitating the use of complex tools.

For an example of training and persuading necessity, in I32P1C4 the leader attempted to get the team to use a complex object-oriented development tool. He did not conduct a concerted training effort, perhaps because the complex package proved more difficult to setup and run than vendors had suggested and was not running, even many months into the project. He did not set a policy for the members regarding temporary use of another ICT means to accomplish the work in the meantime. Members received some individual training on the new tools as they became operational, but this does not appear to have been done systematically. The members continued
to follow the interaction habits they had established in the absence of the new tools. The leader found it very difficult to persuade the members to use the new tools, noting his lack of knowledge about the new tools and resulting necessity of delegating much of the technology facilitation actions.

The leader in this example lacked knowledge of the ICT and was unable to make it work easily. He had trouble persuading the team members and did not conduct training or set rules that would cover the use of the intermediate tools and how they would phase out as the complex development tools came online. So, even when the tools were physically operational, task changes had been made to accommodate their use, and people had been assigned to use the tools, the use change did not occur in team interaction.

5.7 Discussion of Methodological, Theoretical, and Other Findings

Three subsections below focus on some additional findings of this study. They pertain to using adaptive structuration theory (AST) to study virtual teams, the value of critical incident technique with AST for studying technology appropriation, and the current contexts in which virtual teams conduct their projects.

5.7.1 The Usefulness of Adaptive Structuration Theory to Study Virtual Teams

We framed this study using adaptive structuration theory (AST) as an umbrella theory to help us catch all salient aspects of technology facilitation (Figure 2). Using AST provided several key benefits. We found that technology appropriation enables teams to derive value from information and communication technologies (ICTs). Research on technology appropriation and the use of ICTs in virtual teamwork has encountered many methodological and theoretical difficulties due to the complexities involved, particularly, dealing with group-level usage,
replicating appropriation in controlled settings, getting access to field settings, and figuring out how to collect adequate data and what data would be adequate (Fjermestad et al. 1999; Fjermestad et al. 2001; Majchrzak et al. 2000; Martins et al. 2004; Powell et al. 2004). We took a creative approach to solving these issues in this study by combining the very broad theoretical umbrella of adaptive structuration theory (AST) with the very focused, theoretically-grounded, and tested methodology of critical incidents technique (CIT).

The AST conceptual framework guided our questioning and data collection, ensuring that we tapped all relevant areas that might be important to understanding technology appropriation (Figure 2). AST’s covers the scope of structures as cognitive and internal to team members as well as physical and externally manifest in objects and procedures. We found this distinction useful in analyzing virtual team technology facilitation. On the external level, we could ask about the specific ICTs being used and how they were being used. On the cognitive level we could ask about the attitudes team members held regarding the use of the ICTs and how those attitudes impacted the technology facilitation process. Both are salient. In some cases, external, physical aspects of ICTs clearly predominated the technology facilitation (e.g. I25P3C5, I34P1C1). In other cases, it was the internal, cognitive structures that drove attitudes and beliefs leading to the technology facilitation actions the leader took (e.g. I22P1C1, I31P2C4). This distinction led us to a deeper understanding of how structural potential was at work in the lower- and higher-level emergent structures. Without the breadth of understanding in AST, this variety may have been missed or discounted.

AST provided a methodical process view of VT interaction. Many prior studies have taken a deterministic view of virtual team interaction, posing inputs directly related to outputs (Martins et al. 2004; Powell et al. 2004). Perhaps these studies avoided engaging in a process
view due to the difficulty of understanding the elements involved in a complex team process. AST focuses on appropriation of ICTs in groups. Using an AST lens, we could sample this process, parsing the elements of appropriation, cycles of structural change and stability, so that specific episodes of appropriation could be identified and examined. This fundamental function of AST underpins our implementation of critical incident technique (CIT) interviews that focus on critical incidents of technology facilitation.

Each technology facilitation critical incident has at its core an interest in causing technology appropriation in a virtual team. With AST we targeted questions about the appropriation process and were able to dissect the incidents to see if: a) they had complete data on the minimum relevant aspects to identify appropriation: triggers, actions, and structural changes, and b) they were successful or unsuccessful beyond the VT leader’s self report. We could determine the degree of success based on the leader’s expressed initial intent and how the structural changes developed. For example, in incident I31P1C1 the leader initially tried to facilitate the appropriation of Microsoft Project (Table 11). This failed, and he reverted to Microsoft Excel which worked. Though the interviewee reported the incident as successful due to the ensuing reaction and recovery of team interaction, through AST’s appropriation lens we understood the original move to the ICT was a failure.

There have been several controversies about applying AST in empirical studies due to its complexity and seeming inability to predict behavior (Poole et al. 2004). We were aided in applying AST by the use of recent application guidelines that define the elements one must address and how to draw conclusions from these elements (Poole et al. 2004).

We found Poole and DeSanctis’ new AST guidelines very useful. First, we recognized that only two prior studies have examined the actors and moves in virtual teams. Neither
examined technology facilitation nor the appropriation process across multiple virtual teams. Second, we used the theoretical understanding of actors and moves from the new framework to examine the VT leaders and their actions as technology facilitators. This is a strong fit between our theory (AST) and methodology (CIT) given CIT’s focus on the role of a particular type of actor in executing a specified job role. We have found no other studies up to this point that have applied this new framework in research, though we found it very useful and likely to aid in future AST studies.

Future virtual team research would benefit from using Poole and DeSanctis’ updated recommendations on applying AST, as they clarify several key issues, such as how to parse interaction into periods of active appropriation changes versus settled structures and how to deal with reciprocal causation in which the creation of new structures leads to changed technology use and technology use, in turn, leads to the creation of new structures.

5.7.2 Useful CIT-AST Fit for Studying Virtual Team Technology Appropriation

Critical incident technique (CIT) has been used in thousands of empirical studies, primarily in the industrial-organizational psychology field but also in IS and leadership studies (Fivars et al. 2001). It had not been applied to technology appropriation using AST up to now. CIT focuses on job roles, particularly the actors who perform them and the behaviors they perform, and provides methods for sampling and refining the aspects of these roles. The absence of actor and move studies in the VT literature indicated to us that we would need to improve our methods to get the data we sought. We found that prior studies avoided emphasis on actors and moves, because of the difficulty of focusing on just these variables.

The CIT-AST fit in exploring the leader’s role as a technology facilitator in field contexts relies on CIT enabling the sampling of the appropriation episode directly, using the leaders’
experiences, collected in interviews or surveys. Many prior studies have targeted technology appropriation by collecting case data on all interactions that occurred across the life of a virtual team (Majchrzak et al. 2000). While case methods are particularly effective at describing the complete team interactions that surrounded technology appropriation, the overhead burden they impose on data collection for each episode of technology appropriation constrains their ability to collect larger numbers of technology appropriation episodes from multiple contexts at once.

As a result, case methods constrain the ability to study larger patterns within technology appropriation. Laboratory settings can replicate technology appropriation and produce a large quantity of episodes for examination, but the amount of time required for appropriation to take place and the critical importance of contextual factors in driving appropriation deeply challenge the relevance of technology appropriation data collected in this manner, especially when the virtual team (VT) tasks are contrived and projects are as short or shorter than one college semester.

CIT enables the collection of retrospective data from actual practitioners in a position to know what happened with regard to technology appropriation. In applying CIT, specific episodes of technology appropriation could be sampled, the 52 critical incidents of technology facilitation we collected.

CIT enabled collection and analysis of numerous complete appropriation examples side-by-side for comparison. In the end, this resulted in a much more detailed understanding of technology facilitation and the elements of technology appropriation. Future research can now take the empirically-grounded dimensions of the triggers, actions, changes, and outcomes that we found as a starting point for studying technology appropriation in virtual teams.
Content analysis of the AST-CIT data proved challenging in this study. While the available software for coding transcribed texts was adequate (Atlas.Ti 5), the ability to query the resulting codes and develop relationships and numerical frequency data was lacking. As a result, we created a custom database that would allow ad hoc queries using structured query language (SQL). With this custom database we were able to derive many of the tables and data contained in Chapter 4, as well as simple statistics for inter-rater reliability (IRR), such as the level of agreement on presence of a code. We expected the content analysis software might contain routines for automatic calculation of this statistic or other IRR statistics, since they are common to content analysis research (Boyatzis 1998; Neuendorf 2002), but none was supported. We found this software limitation instructive. There is a tendency to ask researchers to do either qualitative or quantitative studies. This study employed a creative design combining AST and CIT, and it required a mix of qualitative and quantitative methods. Perhaps if researchers would give up on the insistence that research be one way or the other, studies like this one would find better support in the existing research tools. As it stands, there is much room for improvement in the software that supports content analysis.

5.7.3 The Nature of IS Development VT Projects

The IS development VT projects we found were large, volatile, and high pressure. We expected team size to remain fairly constant during projects based on our review of 86 virtual team articles. To our surprise, we found that team membership sizes fluctuated in most of the projects, sometimes beginning with fewer than 10 members and often growing to more than 50 then possibly shrinking again as the task progressed.

Volatility also came through in the nature of team member commitment. In 14 projects, team leaders were expected to be both production-line workers as well as team leaders. A fifth
of the projects had 20% or more of the members constantly traveling, a category of team member we had not encountered in the literature review. In 17 of the 30 projects team members were assigned to other projects simultaneously and had to split their time between the competing commitments.

Time pressure also characterized the projects. The leaders of most of these projects considered even one day lost a problem. These projects did not have much slack time in their schedules as a whole. This agrees with prior studies of virtual teams (Powell et al. 2004).

Curiously, only two thirds of the projects included formal orientation training sessions, and only a portion of these, about half, addressed ICT use rules. Only a few addressed ICT use skills, as far as we could tell, but the ones that did were successful in getting members to use complex systems as in incident I28P1C2. Training showed up as a highly prevalent action category in our analysis, but the leaders often did not conduct it proactively. We believe this is a dangerous oversight, especially when a team is trying out a new, complex ICT or a team is trying to bring outside members into using its existing complex ICT. Future research should look at the value of proactive, up-front technology facilitation training in making complex systems work in projects. It appears from our data that there are substantial benefits, and the possible problems from not addressing it up-front and letting time pressure and volatility take hold are hard to surmount.

The number of ICTs in use in each project was also surprising. As previously noted, the median was 12.5. Every team had phone, email, and an audio conferencing tool. Many also had project management tools, fax, calendar, development environment tools, document versioning tools file servers, instant messaging, and teamspaces. Some of these tools were used constantly, like phone and email, while others, such as fax, were important but rarely used. Most prior
research has sampled VT projects in which only one or a few ICTs were being used. Many studies mandated the use of only one ICT. This is not a fair approximation of the reality faced by the VTs found in this study, and it draws into question the applicability of studies that do not somehow represent the variety and complexity of ICTs being used in actual VTs. Being a VT leader is complex, as noted in prior research (Kayworth et al. 2002 VT Leadership). Future research needs to examine how VT leaders can best deal with the complexity of their projects and what role technology facilitation can play in this process.

5.8 Implications for Researchers

Several areas for research in virtual teams appeared in the findings of this study. Several lent themselves to presentation as propositions and have been reported in the eight propositions and two sub-propositions in this chapter. First, we reemphasize the value of using the hybrid AST-CIT methodology, which this study has added. We believe appropriation researchers need to capture rich data with multiple incidents screened to focus specifically on structuration episodes and the AST-CIT methodology used here did that successfully. The methodology in this study did that successfully.

AST, in particular, offers many benefits for virtual team technology appropriation research, including its dual emphasis on process and structure as well as its explanation of change in relation to information and communication technology (ICT) use within teams. It has an additional benefit in that it covers people, task, and technology structures in relation to team interaction. So doing, AST offers the ability to integrate and analyze multiple sub-theories within a larger research framework. As such, AST has served and can serve as an over-arching frame for an appropriation research stream (Poole et al. 2004). This study begins a stream of research on virtual team technology facilitation by defining five constructs in a grounded
appropriation model based on AST. Future research can use these constructs to explore other virtual team technology appropriation contexts. For example, a study could be conducted with leaderless or self-managed virtual teams. Such a context would likely surface different results in terms of technology facilitation and technology appropriation than the formal leader scenario studied here.

Five triggers can spur technology facilitation. Only one is proactive and opportunity-focused. When this opportunity trigger is successful, VTs can gain substantial benefits without incurring a team interaction productivity loss that characterizes the problem triggers. Future research should examine how to enable VT leaders to identify opportunity triggers and take advantage of them.

Technology facilitation and its impact on appropriation relies on leaders’ knowledge, particularly social and technical ICT knowledge (Proposition 5, 5a, and 5b). Future research should also examine leader knowledge in-depth, particularly how the VT leader’s mental model of technology facilitation works and what specific, useful beliefs more successful VT leaders hold.

Such a study might examine how to enable the five areas of belief within leader knowledge. It could develop an instrument for assessing member ICT preferences and test how well it can improve the leader’s ability to facilitate technology use. Another study could look at what ICT training VT leaders need and how to best give it to them, whether up front or making it available on an as-needed basis, or some mix. Another study could look at how to improve VT leader awareness of what ICT solutions are available to them, what they can do with them (appropriation), and how that fits within their role as VT leaders.
Multiple ICTs are used by the average VT in the field. The VTs in this study had problems related to the complexity and balance of these ICTs available to them. Future research should examine what mix of ICTs VTs need, both in terms of task structures as well as people structures. Some of the VT leader beliefs expressed in this study offer starting points for such an inquiry.

The importance of trust and team member relationships proved pervasive, and trust proved capable of overwhelming team interaction when lacking (Proposition 3). Trust had a direct relationship with appropriation that we had not expected. Discovery of this important people structure influence emphasizes the importance to future researchers of studying VTs as socio-technical systems and applying broad theories, such as adaptive structuration theory, in order to capture enough context to adequately interpret the results.

The importance of team participation and information processing capacity was a recurring, dominant theme, as a structural change goal and as a key outcome from technology facilitation. We found this interesting following on a recent call for researchers to revisit the nature of participation in virtual IS development contexts such as the ones we studied (Markus et al. 2004). We now call for additional research on information processing capacity too. Both are key issues for virtual team leaders, and they are not well understood in the VT setting. Participation and information processing capacity appear to be the heart of virtual team leaders’ understanding of team interaction with regard to ICTs, and without changing them, technology facilitation cannot succeed (Proposition 1). Future research needs to address participation and information processing capacity.

Training VT members to use ICTs played a key role in several critical incidents either enabling success when present or contributing to failure, by implication, when absent. The more
dispersed and global a virtual team, the more valuable upfront ICT training is to avoid critical trust and relationship breakdowns (Proposition 4). The more complex ICTs are, the more valuable training becomes in having a successful technology facilitation (Proposition 7). Much of the VT leader’s technology facilitation role had to be carried out mid-project, while the VT leader had many other duties to perform. There is a need to understand how to improve the efficiency of ICT training so VT leaders can more flexibly and with less effort, enact ICT training whenever necessary. How to make this happen is an area for future research.

The nature of virtual leadership also showed itself as different from traditional face-to-face team leadership on the topic of influence. Virtual team leaders attempting technology facilitation have more success relying on persuasion rather than coercion (Proposition 6). One key needed study would identify specific persuasion skills and tactics critical to successful VT leadership. Future research should also examine other ways in which virtual settings change the nature of team leadership.

The training of VT leaders to be successful technology facilitators and the correlation of such training with improved outcomes offers another study for future research. Organizations can improve their virtual team outcomes, simply by recognizing and promoting the VT leader’s technology facilitation role (Proposition 2). A study could undertake defining instruments to assess VT leader knowledge, based on the beliefs categories in this study, and an instrument to assess VT member ICT knowledge. Such instruments would enable a study sampling VT appropriation process success.

Finally, researchers interested in exploring appropriation need to study VTs over sufficient time frames for appropriation needs to develop. In this study, a minimum of two months appeared necessary simply to observe a complete episode of appropriation, though
projects of six to eight months seemed more appropriate as a minimum acceptable length based on the lengths of the projects we studied. Many prior studies have employed university student teams working on two- to eight-week projects. These would not be adequate to display many of the appropriation effects found in this study.

5.9 Implications for VT Practitioners

The VT leaders who participated in this study received a report detailing the outcomes and implications of this study in exchange for their participation. That report is reproduced in Appendix X. This section summarizes many of the key implications shared with the participants.

It is often not enough to simply put together a group of people and begin working on an IS project virtually. One must get them to participate with each other so that information can be processed and outcomes can be attained. Getting this participation to occur in a virtual team (VT) requires trust among team members and the effective use of information and communication technologies (ICTs). Otherwise, team interaction goes astray.

Team interaction problems arise frequently and can cause project failure. These problems can be solved through effective use of ICTs from the phone and email to more advanced software like electronic meeting packages and computer-supported, collaborative application development environments. Two primary issues arise: 1) what ICTs does a particular virtual team need?, and 2) how does one get the VT to use the ICTs effectively? We found answers to both of these questions.

A VT needs a basic ICT toolkit. The teams we studied all had telephone, audio conferencing, and email. The other most frequent ICTs were project management software like Microsoft Project, fax, calendar systems, development environment tools, document versioning tools, file servers, instant messaging, and integrated teamspaces with synchronous meeting
support. In assessing the ICTs necessary in the toolkit, we encountered a need for redundancy particular to VTs. Leaders reported simple technologies like the phone and email failing on occasion. The phone might fail for many reasons, for example, because of poor cell phone reception or because a consultant shares a phone among several cubicles and cannot count on having access. Email seems to have a certain limitation in terms of overload as too many messages get sent from individual to individual and file versions begin to get confused and lost as attachments.

Redundancy and robustness of ICTs is important, particularly in larger, more dispersed virtual teams. As teams grow above 12 to 15 members, VT projects seem to benefit from having a back-up strategy for the phone, especially an eMeeting technology that allows team members to login through the Web so that phone failures do not automatically ensure a member cannot participate. Further, email repositories or other shared, common repositories for archiving textual data and messages as well as controlling their version, seem critical in larger projects, especially if they will span multiple phases or provide information that will be used once the development concludes and maintenance begins. Finally, several teams derived substantial benefits from the use of instant messaging (IM). IM was equated with the virtual water cooler. It’s a medium that apparently allows more casual interaction in current common practice, and it offers a opportunity for team members to socialize, a critical team function that impacts productivity (Ahuja et al. 2003).

If team members are not persuaded to use ICTs, they are unlikely to use them in a virtual team. Classic management techniques involving enforcing rules through mandate did not seem very effective in the incidents studied. Leaders pursuing an enforcement strategy alone had to fly
everyone in for a “talking to” in three incidents. Such meetings are very costly and require team interaction to stop, causing lost productivity.

The more organizations involved in a project and the more physically distant, the more likely entering team members will have different preferences and habits regarding even the simplest and most “comfortable” ICTs: the phone and email. Leaders reported problems originating even from these two. Phones may be shared among cubicle-mates and therefore unavailable except with careful forward planning. Several leaders reported email breaking down in teams with more than five or seven people due to overload, problems tracking down correct versions of attachments, or inability to send large enough files. When even the most “comfortable” ICTs breakdown, the leader needs to create better participation and information processing capacity options. Overcoming members’ high comfort level requires persuasion. The ability to persuade team members virtually critically differentiated the most successful technology facilitation incidents from the others. Selection of VT leaders with skills of this nature would likely yield better outcomes and training VT leaders on persuasion techniques would as well.

Training can also address the initial ICT understandings at kick-off or during mid-project technology facilitations. Getting team members to use ICTs effectively involves initial testing of and training on the ICT toolkit as well as supporting actions once team interaction and productive work begins. All of these actions fall within the purview of the virtual team leader’s technology facilitation role. We were surprised that only 19 of the 30 projects we studied included a formal orientation, and only a subset of those specifically addressed ICT use expectations and capabilities. Each of the projects lacked an orientation had ICT use problems.
We find this is strong support for the importance of conducting a training up front, especially in VTs that include members from multiple organizations.

The members need a chance to develop a joint understanding of the equipment they will be using to interact with each other, and the leader needs to test that equipment up front to ensure there are no permissions, access, or reliability problems. Such problems occurred many times in the critical incidents, and they might have been avoided with a bit more effort up front. So doing, the leaders would have avoided major difficulties and costs that were incurred mid-project. In the case of efforts to add complex ICTs to team interaction, a successful VT leader will not leave rule setting and learning the complex ICTs up to the individual team members. Doing so is a recipe for disaster.

Members must have a clear conception of how to use ICTs and how the ICTs will be useful to them. These thoughts provide the motivation to change. Training provides a forum for conveying this understanding and for persuading team members, whether conducted face-to-face or virtually. Only 25 incidents (48%) included training or persuasion actions. Training, even informal, offers an ideal setting for more easily setting up the base motivation for making ICT use changes. Not using training actions appears to be a serious mistake.

Once project work moves to the main production stage, the team leader must continue to monitor the team’s interaction, troubleshooting problems found and analyzing for improvement opportunities that may arise. Several leaders successfully found opportunities to improve team interaction and capitalized them through technology facilitations during the main production stage. In order to do so they had to be open to change, and they had to have knowledge of ICTs and their capabilities in team interaction. It seems critical for the development of these opportunities that VT leaders receive regular training on current ICT capabilities and how to
examine and understand the usefulness of new ICTs that emerge. When problems arise, VT leaders need to consider what elements of the team’s structure are involved. Is there an external policy interfering? Is the problem related to the design of the team—its size or dispersion? Is the problem resulting from members not knowing enough about the ICTs and how to use them? Are the ICTs themselves inadequate? Is there a fundamental trust problem, not related to the ICTs, that is breaking down team interaction? Knowing to ask and then answer these questions will guide the leader’s technology facilitation actions and help target a more effective response.

A technology facilitation can go well or poorly. Other than gut feelings, two key questions help determine whether a technology facilitation is effective or needs to be retried.

1) Have improvements in participation resulted?

2) Have improvements in information processing capacity resulted?

Ultimately, training VT leaders on their technology facilitation role will help them solve one of the top problems currently facing knowledge worker managers: how to get the most out of knowledge workers and keep work progress rolling (Davenport 2005).

5.10 Implications for ICT Developers

Today’s information and communication technologies (ICTs) have plenty of room for improvement. The leaders we interviewed suggested many types of issues that should be addressed. The main topics were integration/inter-operability and accessibility/performance. A pervasive sub-topic was usability or ease of use.

Integration/inter-operability has two aspects: 1) integration across systems, and 2) inter-operability across different version of the same software. The first aspect included many suggests for expansion of capability. For example, how about building integration tools so that eMeetings can run through DirectTV connections in remote areas where broadband is not
available? How about building IP-telephony bridges into teamroom software so that telephone messages can be automatically bridged for teleconferencing from a universally accessible point and archived in the shared space for later retrieval and use? How about integrating instant messaging (IM) capabilities within teamrooms and eMeetings with standard instant messaging tools and integrating those tools with each other, as current IM clients like Trillian and Fire do, with encryption capability built in? Another common suggestion was integrating multiple tools into a common communication interface like Microsoft Office’s Outlook. Indeed, the next version of Outlook does seem to be targeting this outcome, but it will likely be accompanied by further problems with different versions of Outlook not being interoperable. This second aspect seems trivial but fed several critical incidents. It seems different versions of calendaring programs and IM clients were the biggest problems.

Accessibility/performance centers on making ICTs work more reliably and having them available constantly. Some accessibility problems were as simple as cost calculations in which a leader decided it was not worth initiating an eMeeting due to the per-meeting internal cost his organization demanded due to the vendor’s pricing scheme for the Web service. Perhaps reevaluating product pricing policy would help in such a case. Making a per-project, unlimited use contract possible, for example, might spur greater usage and revenue by making the VT leaders perceive the eMeeting ICT as more accessible as an option. Accessibility/performance also entails the amount of overhead involved in setting up and running an ICT. Two critical incidents (I27P1C1 and I32P1C4, Table 11) involved attempts to use advanced UML-based software development tools. In both cases, the overhead demands in setting up and accessing the tools were enormous and caused failure to use and delays in making the ICTs operational.
Underlying integration/inter-operability and accessibility/performance was usability or ease of use. Virtual team leaders and members are constantly having to deal with a wide variety of ICTs. Often, they implement an ICT for a specific project, and they may never use it again. While the more technical team members and the consultants seem to have the most knowledge of ICTs and ability to flexibly appropriate them, the VTs often contain a mix of non-technical, non-consultant members who must also use the new or existing ICTs. A common solution VT leaders attempted in the critical incidents was to use only “comfort tools,” ICTs such as the phone, email, and audio conferencing, or reduce virtuality to zero to eliminate virtual interaction, but these solutions were costly and belie failure on the part of ICT developers to make ICTs comfortable for users. ICT developers need to put more emphasis on making their products usable and helping VT practitioners see how more usable new products can help save the costs of “comfort tools” and reducing virtuality.

5.11 Limitations

Many of the limitations of this study relate to the choice of methodology. Using the critical incidents technique may lead to several possible limitations. First, CIT data collection is retrospective in that participants must recall events after they happen rather than record them when they occur. We addressed this limitation by carefully framing of the interview process to draw participants back into the situation, collecting an adequately large number of incidents (52), and using currently practicing, successful VT leaders as our information sources. As far as recalled data may be a limitation, research on CIT has shown that recalled incidents have been as effective as direct observation or immediate recording at producing accurate, useful information when the technique is applied using the steps we employed in this study (Flanagan 1954; Hopkins 1987; Saskin 1981).
5.11.1 Dealing with Subjectivity

Subjectivity presents two potential limitations to this study, namely interviewee and researcher personal bias. These are typical limitations of studies conducted in the field using interviews (Klein et al. 1999). In our sample of 52 incidents, we attempted to get leader and member views from three leaders who expressed a willingness to cooperate in the study beyond the initial consent form’s stipulations. Each effort ultimately failed due to privacy and disclosure concerns. However, we did get five incidents reported by the interviewees from the perspective of a team member, a leader on the team not directly technology facilitating (Table 11). We did not see a particular pattern or difference in technology facilitation in these incidents.

Critical incidents were wholly contributed by the interviewees without any corroborating alternate data source. This presents a potential limitation due to interviewee personal subjectivity. Typically, this is a threat to construct validity (Yin 2003). The collection of an adequate number of critical incidents (52) and the use of 13 interviewees with experience in more than 20 major companies helps reduce the likelihood that any one bias exerted influence on our results.

Further, researcher subjectivity could have influenced the outcomes of this study. Formal structuring of the interviews to standardize them, carefully designing and testing the coding process, involving multiple coders across three coding stages, and a consensus process to resolve differences among judges in the second and third coding stages addressed this threat.

5.11.2 Adequate Sample for Generalizing

This study employed intensity sampling, not probability sampling. Thus, the VT leaders sampled in this study came from the IS development field, because of its particular suitability for this study. IS development was characterized by a depth and breadth of VT use in projects, very
technologically knowledgeable workers, a variety of standard methodologies that often do not exist in project work, tight project time lines, and, increasingly, by multi-organizational, multi-national teams. These characteristics that made this field uniquely attractive for this study may also distinguish its behavior from other fields. In as much as this is the case, other fields using VTs may experience different technology facilitation needs. As a result, the findings of this study may not fully apply. Replications of this study in alternate fields would help address this issue. This study has been designed and reported with structured, explicit data collection procedures to facilitate replication.

5.12 Conclusion

Technology facilitation offers a powerful means for improving virtual team success. This study described how virtual team leaders conduct technology facilitation, deriving a grounded and theory-based model that will enable future research. Along with this model, we presented eight propositions and two sub-propositions to guide future research. Additional value from this study derives from the development and presentation of a thorough method for isolating and studying structuration episodes in virtual teams through the application of critical incident technique guided by adaptive structuration theory. Using the extensive included appendices future research will be able to reapply this methodology and further forward our understanding in this crucial area of how to make knowledge work work virtually through the use of information and communication technologies.
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APPENDIX A: INTRODUCTION AND GUIDELINES FOR PARTICIPANTS

This study explores key effective techniques virtual team leaders use to facilitate team technology use. Technology facilitation is one of many virtual team leader roles. Its goal is to enhance a team’s performance. You have been selected to participate in this study as an experienced virtual team leader whose memories of situations encountered during projects can provide useful information about technology facilitation.

You must meet the following conditions to participate:

1. You are currently a virtual team* leader or have been one in the past six months.
2. You lead or have led information systems (IS) development** virtual teams.
3. You have at least one year of experience as an IS development virtual team leader.

* A virtual team is a team that communicates predominantly through information and communication technologies, such as email, telephone, Internet-enabled groupware tools, and FTP sites.

** IS development teams work in software development and engineering, package systems implementation and customization, systems integration and improvement, and related fields.

Benefits
This study will provide you feedback about your own technology facilitation as a virtual team leader. Early participants have reported learning from the structured interview process. You will receive a copy of your transcribed interview and a copy of the findings report. The findings report will include a breakdown of critical requirements for successfully facilitating technology during a project.

For your organization, this research will provide findings about technology facilitation including suggestions on what skills and behaviors are needed and situations in which they would be
effective. These could be used to enhance current training efforts and improve virtual team effectiveness.

**Background**
This study fits into a stream of research at the University of Georgia. We have recently found that technology facilitation is one of the important roles that virtual team leaders must often play whether they want to or not. While we have indications that the role is important, we know little about it. Vendors suggest some solutions leaders can employ, but they are biased toward their own products. Some academic theories suggest possible important factors, but these are too abstract. Since we know of no study that has examined technology facilitation by virtual team leaders in real projects, we are conducting this study. Thank you for your help!

**How to Participate**
Decide if you qualify and return the consent form. You may mail, fax, or email it. You can type your answers directly into the form using a PDF manipulation program, such as Adobe Acrobat. For emailing, you will need to either physically print the form, scan it, and then email it, or you can use Adobe Acrobat to digitally sign it and save your answers. Then email the digitally signed document. On receiving your consent form, we will send you a background form and materials to help you prepare for the interview. These materials will require between 10 and 20 minutes of your attention. At this point you can suggest a good time and date in the near future for you to be interviewed. We will try to do the interview whenever it is convenient for you, even 3 a.m. if that is best! The interview takes two hours. It is carefully structured and detailed. The interview can be handled by phone or in-person, depending on accessibility. The information you provide will be kept strictly confidential with only the research team members having access to any identifying information. We will carefully analyze the data from you and the other interviewees and compose a report of the findings. This will take several
months. We expect to send you a copy of this report in summer 2005. You may contact us at any time during this process to ask questions or comment.

The primary researcher and research team leader is Dominic Thomas, MIS Department, University of Georgia (706) 372-4334, supervised by Dr. Robert P. Bostrom, MIS Department, University of Georgia (706) 542-3559.

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Please contact us with any questions or comments. Thank you for considering participating in this study.

Sincerely,

Dominic Thomas, Primary Researcher “Virtual Team Leader Technology Facilitation Study”
APPENDIX B: HOW TO PREPARE FOR THE INTERVIEW

We want to study “critical incidents” of technology facilitation. Think of virtual team projects in which you had to take action to improve your team’s information and communication technology (technology) use. Each time you took action was a technology facilitation incident. Please focus on significant, critical incidents that demonstrate particularly effective or ineffective technology facilitation. To help you understand the context of the events we seek, know that they can occur for any number of reasons…

• new technologies may become available,
• available technologies may not get used to their full potential,
• technologies in use may become somehow inadequate,
• people may react unpredictably to using technologies,
• tasks may not fit with technologies.

In any one of these ordinary situations, there may be an opportunity to improve the team’s communication and performance through improved technology use. These are just a few examples. There may be other situations that would prompt you to facilitate technology. Think of those occasions when you took action and your action led to changes which impacted the team’s technology use and project performance.

Important points: Technology facilitation is what you are doing when you intervene during your team’s project to improve your team’s technology use. A “critical incident” is an occasion when you acted and your action(s) made a big impact on your team. A “critical incident” of technology facilitation has three characteristics:
1. It is an occasion in which your intervention **really made a difference** in the way the team used information and communication technology (ICT) and **clearly impacted** the project outcome.

2. It is an incident that went **unusually well or poorly**.

3. It must be nested in a typical or **ordinary situation**.

Considering the above characteristics, **think of four or five critical incidents** when you facilitated technology in a virtual team project you led. If you come up with more than five, that is fine. It will be helpful if you can write down a short reference name for each incident and its project. Be sure to use names that easily remind you of the specific incidents and projects. We will use these names during the interview. Note: it is fine if you have more than one critical incident from the same project.

**Questions for the Interview**

During our interview, we will go through questions like those below but in greater detail for each project and critical incident. If you have time, please prepare notes before the interview. They would likely be helpful during the interview.

**Remember the project** in which the incident occurred. Remember the people involved. What were their roles and responsibilities? Remember the tasks. What goals did you have? What information systems (IS) development methodology was the team using if any? Remember the technology. What information and communication technologies (ICTs) was the team using?

**Remember the episode.** We refer to context surrounding the technology facilitation incident as an episode. At the time you decided to intervene, what was happening? When did you no longer feel the need to intervene?
**Remember the critical incident.** How did you intervene and what action(s) did you take?

What was the immediate impact of your action(s) on the team’s technology use? How did the change in the team’s technology use impact the outcome(s) of the project?
APPENDIX C: LEADER BACKGROUND FORM

Name:_________________________________________________

Email:________________________ Phone: _____________________

Street:________________________________________________________________________

City:__________________ State: __________ Post Code: ____________ Country: ________

What contact method do you prefer? ______________________

When would be a good date and time for this interview? ______________________________

**Definition:** “Virtual teams” are those in which a majority of the interaction took place
through information and communication technologies including but not limited to the telephone,
email, groupware, file servers, etc. At least 51% of the interaction must be non-Face-to-Face.

Please attach a copy of your résumé. If any of the following questions are not clear from
your résumé or you would prefer not to attach a résumé, answer questions 1-6. They cover
general information about your virtual team leadership experience, education, and current job.

Please check (√) the blanks that apply to you and fill in the information requested.

Education [check all that apply, write in a number if multiples of an item. For example,
if you have two Masters degrees, write “2” in the Masters blank.]:

_____ Doctorate_____ Trade School/Business Certifications

_____ Masters_____ High School Diploma

_____ Bachelors_____ Other: ______________________________

What major area(s) have you studied? ______________________________

What is your background in Information Systems (IS) work?

What is/are your area(s) of expertise? ______________________________
What is your current job title? ________________________________

What is your current organization? ________________________________

Please answer questions 7-9. They cover general information about you that probably is not clear from your résumé or from above.

Your overall amount of non-virtual team leadership experience [number of years and months]:

   Time: ________ years _________ months

Your overall amount of virtual team leadership experience [number of years and months]:

   Time: ________ years _________ months

Number of virtual team projects led [circle one]:

   Over 20   16-20   11-15   5-10   2-4   1

Average duration of these virtual team projects in months: _________ months

What is your native language? ________________________________

In what other languages are you fluent? ________________________________

How would you rate your success as a virtual team leader? [Circle one number.]

   (Very Poor)  1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 (Very good)
APPENDIX D: CONSENT FORM

I agree to take part in the interview portion of a research study titled Virtual Team Technology Facilitation, which is being conducted by Dominic Thomas, MIS Department, University of Georgia, (706) 372-4334 under the direction of Dr. Robert P. Bostrom, MIS Department, University of Georgia, (706) 542-3559. My participation is voluntary; I can stop taking part at any time without giving any reason, and without penalty. I can ask to have information related to me returned to me, removed from the research records, or destroyed.

Virtual teams' increasing importance to global business and the lack of understanding of how to make them effective motivates this study effort. This study will provide feedback to me about my own technology facilitation as a virtual team leader. I will receive a copy of my transcribed interview and a copy of the findings report. The findings report will include a breakdown of critical requirements for successfully facilitating technology during a project.

If I volunteer to take part in the interview portion of this study, I will be asked to do the following seven things:

1. Make sure that I qualify for the study. I must have led virtual, IS development project teams for a total of one year.
2. Fill out and return this consent form and the leader background form.
3. Make myself available for interview. The primary researcher will contact me to arrange this interview.
4. Prepare. I will read the How to Prepare for the Interview sheet prior to the interview. I will prepare notes if I have time.
5. Be interviewed. The interview will last approximately two hours. Interviews will take place in November and December.
6. Receive and review the transcript of my interview when it arrives within two months after the interview. If I find any inaccuracies or identifying remarks, I will correct them and return a copy of the changes to the research team.

7. Receive a copy of the findings report.

No risks are expected in this interview. The information I give will be confidential. The interview will be recorded, and I will have the right to review the recording and transcript. Only the researcher and his committee will have access to the recording. It will be stored in an encrypted computer repository and erased after seven years. Its transcript will be stripped of any information that identifies me and my company. I understand that this identity-striped information may be published or used in further studies.

The researcher will answer any further questions about the research, now or during the course of the project, and can be reached by telephone at: (706) 542-4665 [work] or (706) 372-4334 [cell] or (404) 373-8296 [home].

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Primary Researcher: Dominic Thomas

MIS Department, 312 Brooks Hall, University of Georgia, Athens, Georgia 30602-7411;

Telephone (706) 372-4334; Email dominict@terry.uga.edu

Participant: _______________________________     ________________________________
Name (in print)                                           Signature

Date signed: ______________________________
Additional questions or problems regarding your rights as a research participant should be addressed to Chris A. Joseph, Ph.D. Human Subjects Office, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; Email IRB@uga.edu.
APPENDIX E: PROJECT DESCRIPTION GUIDE

Project Description Guide purpose: During the interview, I will ask you a set of background questions for each project that closely follow the items listed on this guide. If you would like to prepare answers on this form for each project in advance, please feel free to do so. I will want to go through the form verbally during the interview to ensure that I understand all of your answers and to create a shared reference point for discussing the critical incident(s) within each project.

Project reference name: _________________________

Longevity of the project (months): _________

Team history prior to this project:

   New client / On-going client

Developers had worked together:

   Little to none / A few times / Many times

Formal leader role: Worker-Leader / Team Leader Only

   Ultimate Project Manager / Top-tier Project Leader / Lower-tier Leader

   The only designated leader / One of multiple designated leaders

How many people were on the team? _________

   Were they grouped within the team? YES NO

   [For instance, there may be sub-teams, different functional units, etc.]

   What were the groups? ________________________________

   What were their roles? ________________________________

How many organizations and firms were represented among the team members? ______ organizations _____ firms [Organizations include major divisions within a firm with distinct administration.]
Who was in which organization? ________________________________

[Note: Can use pseudonyms or aliases to cloak people & org. names if necessary.]

How many national cultures were represented among the team members? ____

In terms of countries and time zones, where were the members located? [give a percent (%), if one is adequate to describe all members, mark one option 100%. Otherwise, give percents for quantity of members in each condition if more than one answer applies. For example, there might be 80% of the members in the same country, same time zone while 20% are constantly traveling.]

____% same country, same time zone
____% same country, multiple time zones
____% two countries, same time zone
____% two countries, multiple time zones
____% three or more countries, multiple time zones
____% constantly traveling… no usual location

With how many members did you share a native language? ____

Oftentimes, teams are filled with members with varying amounts of experience. Was this the case? [circle one] YES NO

If not, how experienced were the team members in this sort of project [scale of 1-5]? (Very little experience) 1 – 2 – 3 – 4 – 5 (Very experienced)

Did any team members enter or leave during the project? Why?

Were members assigned solely to this project or did they split their time?
What information and communication technologies (ICTs) were available for your team’s use at the beginning of your project, include non-computer technology such as mail if applicable? (Circle or write-in and circle these items in the table below. The ICTs listed are only samples, they are in alphabetical order.)

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<td></td>
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</tr>
</tbody>
</table>

What was the IS project’s [task] nature (central goal)? ______________________

[e.g. installing packaged software, converting a legacy system, building a new system from scratch, adding on to an existing IS, analyzing and designing, other]

Did the team go through a formal orientation at the beginning of this project?

If so, briefly, what was covered?

Did the team go through a formal wrap-up session at the end of the project once the product was complete?
If so, briefly, what was covered?

Who initiated this project? ________________ Briefly, why?

________________________________________________________________________

How often did you meet as a whole team face-to-face? using which ICT(s)?
[*Frequency scale: daily, weekly, monthly, quarterly, rarely – Choose the best option.]

Frequency * ________________ ICT(s) __________________________

How often did you synchronously meet as a whole team virtually? using which ICT(s)?

Frequency * ________________ ICT(s) __________________________

[If frequent meetings existed, at what point in the project did this pattern get established?]

Did you have irregular (unscheduled) meetings? ________ Which ICT(s) did you use for these? ________________

For managing your project, what were your internal metrics or indicators of project status and success?

Briefly, how did the project rate in the end on these metrics?

How would you characterize the status of this project at the end on a scale of 1-10 from complete failure to complete success? [Number:] _____

What other notable outcomes did this project have for team members, the team as a whole, and the organization(s) involved?

Were you using a specific IS methodology to accomplish your project?

If so, what was it? __________________________

Was it mandated? __________________________

If so, by whom? __________________________

How strictly did you adhere to your methodology as a team [scale of 1-5]?
(Very little adherence) 1 – 2 – 3 – 4 – 5 (Very strict adherence)

If not, how would you characterize the methodology followed in this project?

How structured/flexible was it? __________________________
APPENDIX F: RESEARCHER’S INTERVIEW GUIDELINES

Pre-Interview
Send introductory packet indicating the nature of the research study, how to consent, what background information is required, and how to participate.

Ensure leader willingness to participate:

Do you have the completed consent form?
If so, schedule the interview.
If not, contact leader to follow up.

Interview Preparation
Gather necessary materials:

- Introductory packet materials extra copy
- 5 Project Context Forms (PCF) and 1 Project Description Guide (PDG)
- at least 2 pads of paper and 3 working pens
- IPod with recording equipment for either FtF or telephone as appropriate
- Back-up recorder (optional)
- Researcher’s Interview Guidelines (this document), 5 copies of Critical Incidents Questions and 1 copy of General Questions
- IRB Consent form (needed if FtF and consent form is not already done)
- Leader Background Form (needed if not already completed)

Make sure the location is suitable for interview (quiet, private)

Have email, FTP, and high-speed internet connection available during telephone interviews in order to send PDG if necessary.

Interview
Introduce self and thank the leader for participating.

Give timeline for study:
Explain outcome of today’s interview (based on introductory letter and packet)

Confirm reason for his/her selection to participate

Experience and success in virtual IS project teams as a leader

Review protocol issues:

Mention confidentiality

Mention recording and confirm permission to record

Review the **framing** of the research.

[FRAME] “Think of virtual team projects in which you had to take action to improve your team’s information and communication technology (technology) use. Each time you took action was a *technology facilitation* incident. Please focus on significant, *critical incidents* that demonstrate particularly effective or ineffective technology facilitation. To help you understand the context of the events I seek, know that they can occur for any number of reasons… new technologies may become available, available technologies may not get used to their full potential, technologies in use may become somehow inadequate, people may react unpredictably to using technologies, tasks may not fit with technologies. In any one of these ordinary situations, there may be an opportunity to improve the team’s communication and performance through improved technology use. These are just a few examples. There may be other situations that would prompt you to facilitate technology. Think of those occasions when you took action and your action led to changes which impacted the team’s technology use and project performance.”

*[optional clarification: TECHNOLOGY FACILITATION]* “**Technology facilitation** is what you are doing when you intervene during your team’s project to improve your team’s technology use.
**optional clarification: CRITICAL INCIDENT of TECHNOLOGY FACILITATION**] A **critical incident** of technology facilitation is an occasion when you acted and your action or actions made a big impact, *either unusually positive or even unusually negative*, on your team’s use of technology. This change in technology use in turn led to real changes in the team’s performance on the project. In terms of context, a critical incident takes place during a normal or ordinary day-to-day situation.

**Overview** of how we will proceed today:

[Give them paper and a pen if FtF and necessary. Modify comments like the first one if it is clear they have notes, replace the first sentence with something like, “I see you have brought some notes.”] “You have had a chance to think about and perhaps write some notes on critical incidents of technology facilitation you have experienced. We will be going through those experiences in this interview. For each incident, I need to know the project context in which it took place. I will go through a context form for each new project and fill it out while you answer the questions. Next, we will go through the incident or incidents from that project. So, it would be helpful if you can go ahead and group your incidents by project if you have more than one from the same project.” [Check response, continue when ready.]

“Now, go ahead and think through your incidents and write down a reference name or phrase for each. Try to pick a name that will instantly remind you of this incident.” [Allow time for leader to do this. Have him/her tell you the names if by phone so that you can write them down.] “Does your list have more than five critical incidents?” [IF so…] “In the given time, we will be able to cover five at most. Look through your list and choose the five that you think are the best examples of technology facilitation impact team performance. Star those. We will
cover those today.” [end IF so] “Go ahead and write reference names for the projects if there are more than one.” [Confirm answer and continue when ready.]

“Each incident is a separate mini-interview. In each mini-interview we will discuss the critical incident or critical incidents and its/their surrounding context, the *episode* in which the incident or incidents occurred. After we go through all the incidents and projects, I will ask you some general questions about your experience. Ok, let’s begin. I will turn on the recorder and we will go through the first project.”

**Begin**

Turn on recorder, make sure it is working.

Get Project Context Form (PCF)

Get project and first incident reference name and write on PCF

Give a PDG to interviewee to follow if he or she did not bring one from the Intro. Packet. If online, have him or her download it from www.dominict.net/project.pdf, or you can fax, FTP, or email one.

Go through PCF

Go through Critical incident questions

Ask leader and take a brief break if necessary. Check if next incident is from a new project.

If so, go to b.

If not, go to c.

After all incidents, ask General Questions.

**End**

Thank the leader for participating.
Remind about confirming the transcriptions later.

Get any immediate feedback about the interview and research process.

Talk about the next steps.

We will transcribe this interview and send the transcription to you within two months.

How would you prefer to receive this? (printed, email [what form? PDF, Word?], fax) -

Ensure that the contact information is complete for whichever form they choose.

Review the transcript.

If you have any corrections or comments, contact us within three weeks of receiving the transcription.

If it is fine, send a confirmation note if you have time. If you fail to contact us, we will assume that the transcription is fine and go ahead with our analysis.

Receive the final report, sometime next summer.

Update your contact information to us if it changes.

Thank the leader again and adjourn.
APPENDIX G: CRITICAL INCIDENT QUESTIONS

Interviewee ID: ______ Incident reference name: _______________________

**Interviewer Instructions:** Have interviewee focus on one critical incident. Remind the interviewee of the frame if necessary. It’s located on the Researcher Interview Guidelines document. After giving the interviewee some time to recall the incident (using his or her notes if any), collect the following information. Each numbered question corresponds to one idea from the focus of investigation. The idea is given next to the number and only provided for interviewer reference. The question texts following each title are designed to be read aloud verbatim. Text in brackets refers to notes, probes, clarification, or alternate methods to ask. These are optional and left to the interviewer’s discretion. **Timing:** This is a long interview. Some questions can be skipped if time is short in order to cover more incidents. Questions that may be skipped due to time constraints are marked [*skippable].
1. Project Context. [If this is not the first incident covered, ask if this incident comes from a project already discussed in this interview. Give the interviewee a Project Description Guide (PDG) to follow and guide the interviewee through the PCF unless this incident’s project has already been covered in another PCF. For phone interviews, have the interviewee navigate to www.dominict.net/project.pdf to see a PDG. For FtF, hand the interviewee a PDG. NOTE: a project may have multiple phases that are fully contained, including complete deliverables that get implemented and used. In such a case, a phase can be considered a project. Make a note on this form if the context of this incident is a phase of a larger project. ]

Write the project reference name here: ____________________


I want to know what you did. Imagine that you have been placed back in time into that episode. What was the incident and what exactly did you do or say? [Note: Go for actual actions… Tell me exactly what happened, what you said or did at that time. Clarification: And you, what did you do? What did you say? Probe (as necessary): Did you modify any goals or methodology steps in acting? Did the members have to have additional ICT knowledge? Did you sanction or reward any of the members? Did the members’ roles within the team change in any way? ]

What were team member related issues in this incident? [Probe (as necessary): Did the members have to have additional ICT knowledge? Did you sanction or reward any of the members? Did the members’ roles within the team change in any way?]
What were project task related issues in this incident? [Probe (as necessary): Did you modify any team goals? Did you change or rearrange any of the work process or methodology steps? ]

How did you use members’ ICT knowledge in this incident, if at all?

When during the project did this incident happen? [Note: Interviewee must give enough answer to at least distinguish between the beginning, mid-project, and end of project.]

3. Effectiveness and evidence of appropriation.

Do you consider this an effective or ineffective incident? [Circle One] [Clarification: An effective incident is one in which your effort to improve technology use worked.]

Effective - Ineffective

What evidence do you have of some change in the team’s use of technology due to your action(s)? What did you see, hear, or feel? [Alternates: How did you know that your intervention was effective/ ineffective? If someone asked you to prove that team technology use changed following your intervention, how would you respond?]

4. Reflection on outcomes. Project, members, team, leader and organizational levels.

In terms of the project’s goal, how did the team’s change in technology use result in a different outcome? [Alternate: How did the team’s changed technology use contribute to/ detract from the project’s goal?]

[*skippable] At the end of the project, how do you think the change in technology use impacted the individual team members? The team collectively? [Alternate: What did
the individual team members and the team collectively take away from the changed
technology use?]

[*skippable] What was the impact on you as a leader resulting from this incident?

[Clarifications: Did you learn something in the process? Or change your approach?
What, if anything, did you find particularly satisfying about the situation?]

[*skippable] Was there some impact on your organization or another of the
organizations due to the change in technology use from this incident? What was it /
what were they?

5. Trigger.

What do you think caused you to intervene? [Alternates: What triggered you
facilitating the team’s technology use? Were there any issues with the technology
itself, task goals and methodology, or people’s roles and responsibilities that
prompted you? Were you targeting a specific outcome when you intervened? What
was it? Why did you intervene?]

6. Duration.

What marked the completion of this episode? When did the team stop focusing on
changing its technology? [Probe, if the team focus did change: What led to this
change?]

7. Reflection on leader’s personal fit.

[*skippable] What specific capabilities or skills made (or perhaps would have made) it
possible for you to perform effectively in this episode?

8. Reflection on leader action.
When you reflect back on the experience, would you have done anything differently?

[Note: This question shifts focus from description of being in the appropriation episode to reflection on personal performance during the episode.]

9. Reflection on leader use of mental model.

[*skippable] Looking back on the incident, what did you assume, believe or value that affected what you did?

10. Criticality.

Why was the incident “critical”? [Alternate: What makes this incident critical?]
APPENDIX H: GENERAL MODEL QUESTIONS

Interviewee ID: _____________

These are general questions that relate to the leader’s overall approach to improving team performance through technology use. Prompt the interviewee to pause for a moment and think about his or her general experience facilitating technology. This is a good time for a brief break for water or toilet if needed. Write in the critical incident reference names below during this pause.

Read aloud to begin: “We have just gone through a lot of details about projects and critical incidents that occurred. Now I would like you to think about [Note: add incident reference names here] _____________________, _____________________, _____________________, _____________________, and _____________________, and any other technology facilitation experiences you have and answer a four general questions to wrap up this interview.”

Importance and Frequency of Technology Facilitation. “You have a lot of duties as a team leader beyond technology facilitation.”

“On a scale of one to ten where one represents total non-importance and ten represents absolute, critical necessity, rate how important it is for you to facilitate technology in the teams you lead.” Numerical answer: ________________

“Please explain why you gave this answer”: 

“On a scale from one to ten where one represents never and ten represents constantly, how often does the need for technology facilitation arise once the project work begins?” Numerical answer: _________

“Please explain why you gave this answer”:
Technology Toolkit. “For each project, we went through which information and communication technologies (ICT) were available and which were actually used. Every virtual team needs a set of ICT options… their technology toolkit.”

**To the interviewer:** Mark the listed technologies on the chart on the next page and write in new ones as they answer. Star (*) critical ones. Double-star (**) most critical ones. “From your experience, what technologies would you include in this technology toolkit? Which ones are the most critical? Why?” [Probe: If a technology is left out that would seem important, ask why it was not included.]

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“How could ICTs be improved or what needs to be invented to help virtual teams better perform?”
Mental Model.

“How do you facilitate technology use? What’s your general approach?”

“Research has shown cultural and regional preferences for using different information and communication technologies. Research has also shown that people vary in their beliefs about which technologies are good for which tasks. In virtual IS project teams, are there certain combinations of people and technology or task and technology that are doomed to fail? What are they? Are there some that work particularly well? Which ones?”

Knowledge:

“What does a VT leader need to know to be an effective technology facilitator?”

[*skippable] “How much technical knowledge of the usefulness of specific features of information and communication technologies (ICTs) does a virtual team leader need?

[Clarification: Usefulness refers to the capacity of features to support task needs.]

[*skippable] “How much technical knowledge of the ease of using specific features of information and communication technologies (ICTs) does a virtual team leader need?

[Clarification: Ease of use refers to the amount of effort required to use the features.]

[*skippable] “How would you rate your own technical ICT usefulness knowledge on a scale from 1 to 10 representing total weakness to complete virtuosity?” Number: ___

[*skippable] “How would you rate your own technical ICT ease of using knowledge on a scale from 1 to 10 representing total weakness to complete virtuosity?” Number: ___

“What skills does a VT leader need to have to be successful as a technology facilitator?”
APPENDIX I: PROJECT CONTEXT FORM (PCF)

Project reference name: _________________

Longevity of the project (months): _________

Team history prior to this project:

New client / On-going client

Developers had worked together:

Little to none / A few times / Many times

Formal leader role: Worker-Leader / Team Leader Only

Ultimate Project Manager / Top-tier Project Leader / Lower-tier Leader

The only designated leader / One of multiple designated leaders

How many people were on the team? _________

Were they grouped within the team? YES NO

[For instance, there may be sub-teams, different functional units, etc.]

What were the groups? _____________________________

[probe: What were their roles? ______________________]

How many organizations and firms were represented among the team members? ____ organizations _____ firms [Organizations include major divisions within a firm with distinct administration.]

Who was in which organization? _____________________________

[Note: Can use pseudonyms or aliases to cloak org. names if necessary.]

How many national cultures were represented among the team members? ____

In terms of countries and time zones, where were the members located? [give a percent (%), if one is adequate to describe all members, mark one option 100%. Otherwise, give
percents for quantity of members in each condition if more than one answer applies. For example, there might be 80% of the members in the same country, same time zone while 20% are constantly traveling.]

[Blank]

____% same country, same time zone

____% same country, multiple time zones

____% two countries, same time zone

____% two countries, multiple time zones

____% three or more countries, multiple time zones

____% constantly traveling… no usual location

With how many members did you share a native language? ____

Oftentimes, teams are filled with members with varying amounts of experience. Was this the case? [circle one] YES NO

i. If not, how experienced were the team members in this sort of project [scale of 1-5]?

(Very little experience) 1 – 2 – 3 – 4 – 5 (Very experienced)

Did any team members enter or leave during the project? Why?

Were members assigned solely to this project or did they split their time?

What information and communication technologies (ICT) were available for your team’s use, include non-computer technology such as mail if applicable? (Circle or write-in and circle these items in the table below.)
What was the IS project’s **[task]** nature (central goal)? __________________

[e.g. **installing** packaged software, **converting** a legacy system, **building** a new system from scratch, **adding on** to an existing IS, **analyzing** and **designing**, **other**]

Did the team go through a formal orientation at the beginning of this project?

If so, briefly, what was covered?

Did the team go through a formal wrap-up session at the end of the project once the product was complete?

If so, briefly, what was covered?

Who initiated this project? ________________  Briefly, why?

______________________________

How often did you meet as a whole team **Face-to-face**? using which ICT(s)?

[*Frequency scale is “approximately”: daily, weekly, monthly, quarterly, rarely*]
Frequency * __________________ ICT(s) ______________________

How often did you synchronously meet as a whole team **virtually**? using which ICT(s)?
Frequency * __________________ ICT(s) ______________________

[If frequent meetings existed, at what point in the project did this pattern get established?]

Did you have irregular (unscheduled) meetings? ________ Which ICT(s) did you use for these? ________________

For managing your project, what were your internal metrics or indicators of project status and success?

Briefly, how did the project rate in the end on these metrics?

How would you characterize the status of this project at the end on a scale of 1-10 from complete failure to complete success? [Number:] _____

What other notable outcomes did this project have for team members, the team as a whole, and the organization(s) involved?

Were you using a specific IS methodology to accomplish your project?

If so,

What was it? ____________________________

Was it mandated? ____________________________

If so, by whom? ____________________

How strictly did you adhere to your methodology as a team [scale of 1-5]?

(Very little adherence) 1 – 2 – 3 – 4 – 5 (Very strict adherence)

If not,

How would you characterize the methodology followed in this project?

How structured/flexible was it? ____________________________

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APPENDIX J: CODEBOOK AND CODING DOCUMENTS FOR FIRST STAGE

Instructions for Round 1 Coding Task

Introduction

You will be reading transcripts of interviews with project team leaders. In each interview, the team leaders talked about critical incidents of technology facilitation. An “incident of technology facilitation” is an occasion when a team leader takes action to improve team communication or interaction by improving the team’s information and communication technology (technology) use. It becomes “critical” if it is particularly effective or ineffective. In most cases, the interviewee was the person facilitating technology. In some cases, the interviewee was acting in conjunction with other team leaders, and in a few cases, the team leader was a team member observing the actions of a team leader.

When you code, you must find and mark quotes in the transcript that fit the definition of a code. Many passages may be irrelevant due to digressions and chit-chat during the interview. Instructions are included on the pages that follow.

The transcript label indicates the interview number, project number and critical incident number, for example, “I27P1C2” stands for Interview 27, Project 1, Critical Incident 2. Each transcript has been pre-screened to ensure that all material relating to its critical incident has been included. As a result, some critical incident transcripts include disjoints indicated by timestamps in parentheses-(1:20:34)- or notes in brackets, such as “[skip to section 2].” These indicate that the interviewee jumped topic in the middle of the discussion and, as a result, the researcher had to move the material related to another incident so that it would be in its appropriate place and not contaminate the information in the critical incident transcript you are reading.

The researcher transcribed the interviews verbatim. Consequently, they are a textual representation of spoken English, complete with some sentence fragments and potentially
unclear exchanges between the interviewee and interviewer. Please use your judgment and the context to understand whatever you can if difficulty arises. Additionally, due to inability at typing, long hours at night, or other complicating factors, there may be grammatical mistakes or typos in the transcript. Please use your judgment and work around these if found.

**Contact**

If you run into any difficulties or have any questions or comments, contact Dominic at dominic@dominict.net or on his cell phone at 706-373-8296 or at home on 404-373-8296.
Coding Process

1) Instructions:
   a. In brief, you will be coding one or more critical incident transcripts.
   b. As much as possible, be objective and methodical in coding. If you get tired, take a break. If you feel that you cannot focus, please do not continue coding until you can focus. Your codes will be used in data analysis and any errors or bias due to tiredness or lack of focus will greatly reduce the value of your codes.

2) To do:
   a. **Familiarize yourself** with the codes and their definitions on page four and five. Keep them handy while you code so that you can refer to them as necessary.
   b. **Open Atlas.ti.** See the instructions on page six for installation and setup and screen shot on page seven for a properly setup installation of Atlas.ti. Next, open the hermeneutic unit (a file containing the critical incident sections and the codes formatted for Atlas.ti). **Login** as yourself (see p.5 Setup for instructions).
   c. There are four drop-down boxes across one of the menu bars at the top of the window. In the first one “P-Docs”, **select the document** with “I25P3C5” in its name. The interview transcript section will display in the primary document viewing area. (We will use the I25P3C5 critical incident for practice coding during training.)
   d. In the “Codes” menu, open the “Code Manager.” This opens a list of the existing codes. It should show the codes defined on page four and five.
e. Code.

i. Read the transcript section once to familiarize yourself with it. During this read, identify at least one structural trigger, one leader action, one structural outcome, and one team outcome in the critical incident. Think through the flow of the incident. It may not be obvious, but each incident tells a causal story of technology facilitation.

ii. Re-familiarize yourself with the codes on page four and five.

iii. Read the transcript again. When you find one or more sentences indicating a code, highlight it or them. Do this by double clicking a word in a sentence twice, or for multiple sentences, use the mouse to click-hold at the beginning point and release at the end point of where you want to highlight. Next, click on the applicable code in the Code Manager window to select it. Then, click-hold on a word in the code to drag the applicable code from the Code Manager code list to the highlighted text. Release the button and you should see the code appear in the margin display to the right of the transcript viewing area.

Notes:

1. Code whole sentences as a rule. Due to the oral nature of these transcripts, some sentences are long and contain multiple thoughts. Do not select partial sentences unless you feel a very strong need and there is a very clear break defining multiple parts to select.
2. Code **only one code per** sentence or group of sentences. Do not code a sentence, sentences, or a sentence part with multiple codes unless you feel there is a very strong, clear need.

   iv. After coding the whole transcript, scan it once more to ensure that you are comfortable with your codings. Make changes as necessary. You can remove a code by right-clicking on it in the code viewing panel to the right of the primary document viewing area and selecting “unlink” from the contextual menu that appears.


   g. If you are going to code another document, go back to step 2.c and select it to begin the coding process again.

   h. When you have finished coding, save your work and close Atlas.ti. Notify Dominic at dominic@dominict.net that you have finished.

   i. THANK YOU for your time and help.
Code Definitions

* You must find at least one structural trigger, leader action, structural outcome and team outcome in each incident text. There may or may not be any mental model beliefs or electricity.

* You do not need to code all of the text. Code only the passages that you think specifically pertain to a code. Many passages may be digression or chit-chat and may not have any applicable code.

1. Structural Trigger

A structural trigger is a specific condition that existed prior to technology facilitation action(s) being taken, especially any condition specifically noted as a cause or prompt of technology facilitation. Structural triggers include ways which people, tasks, technology, and organizational factors were acting individually or were interacting with each other. Code:

a) Mention of any conditions attributed as causes of action.

b) Descriptions of specific, preexisting conditions regarding the people, tasks, technology, or organizations prior to or during the technology facilitation.

2. Leader Action

A leader action is an action taken by a leader during a technology facilitation incident. It may be the action taken by the interviewee as well as action taken by other leaders and reported by the interviewee. These will often be indicated in discussion of what “I”, “she” or “he”, or “we” did in the given situation. Code:

a) Any mention of specific activities undertaken by a leader or team member in addressing the critical incident.

b) Any mention of technologies tried or tested for possible use.

3. Structural Outcome

A structural outcome is the result of (2) leader action. It is usually an emergent way in which technology comes to be used for work by one or more members of the team, but it can also be marked by the
absence of a change, especially when technology facilitation fails. Structural outcomes manifest in changes in technology use for work which can be accompanied by changes in people, tasks, and organizational factors, such as roles, work processes, and organizational security policies respectively. All such changes that enable the changed technology use are part of the structural outcome. Code:

a) Any report of a change in information and communication technology use that was put into practice for work (i.e. not just tried, but actually used for work) even if only once.

b) Reports of specific people, task, or organizational changes that supported the technology use change.

4. Team Outcome

A team outcome is the value of the (3) structural outcome for the team, whether in work productivity or some other way. It is indicated by any reported impact on the project, the team members, the team as a whole or the organizations involved attributed to the structural outcome. Code:

a) Any report of work productivity impact (improvement or deterioration) due to the structural outcome. These include intermediate impacts, such as communication improvements, or final results, such as project deadlines missed.

b) Any report of how the structural outcome impacted individuals, the team or one or more organizations. This includes any lessons learned in the incident or any further actions taken as a result of those lessons, such as restructuring or work redesign.
5. Mental Model Belief

A mental model belief is a general thought about how people, tasks, technology, or organizations individually behave on their own or interact in combination with each other during virtual team project work. It is distinct from a structural trigger in that it states a general opinion drawn from the interviewee’s experience. Code:

a) Opinions about causes and effects regarding technology or teamwork in general, drawn from the leader’s previous experiences or knowledge.

b) Statements of general opinion about how people, tasks, technology, and organizations should be or work best.

c) Statements of the general meaning of a thing, a situation, or a relationship.

d) Statements of general rules about how things operate in general, including limits and capabilities.
Atlas.ti Installation and Setup Instructions
Installation (Only for Microsoft Windows)

1) Put the “Coding_Docs” folder at the root of your system drive, which must be drive letter “C:” (i.e. C:\Coding_Docs\). The software has some hard-coded paths that will break if the folder is anywhere else. This folder will have been delivered to you in one way or another by Dominic.

2) Double click the file named “A5Setup.exe” located in the Coding_Docs folder to begin installing Atlas.ti.

   Registrant Name: XXXXX   License Key: XXXXXX-XXX-XXXX

3) [optional] If you have Windows XP Service Pack 2 installed, you will experience better performance and reliability if you upgrade Atlas.ti to Build 63. You can do this by following the instructions at http://www.atlasti.com/servicepack.shtml.

Setup

1) After you have installed the basic software package, run Atlas.ti. Open the User Editor in the “Extras” menu. Add yourself as a user using the username and password provided for you. This username is case sensitive and must match the one provided to you or the file will not open.

2) Choose “Login” from the “Extras” menu and login as yourself.
3) You will have received an invitation for a Groove shared folder named “Coding_Docs.” If you have not done so already, create the folder at the root level of your C drive (i.e. C:\Coding_Docs\).

4) Select the command Tools>Copy Bundle>Install Bundle (on Copy Bundle sub-menu of the Tools menu). In the dialog box, navigate to the bundle for you located inside the folder labeled with your first name in the “Dominic_Dissertation” folder inside “Coding_Docs” (i.e. C:\Coding_Docs\Dominic_Dissertation\**YOURFIRSTNAME**). Accept the default settings and click “Unbundle”. This will create a “hermeneutic unit.”

5) Choose “Save as” from the File menu and save the unit with its default name inside of the same folder, the one labeled with your first name in “C:\Coding_Docs\Dominic_Dissertation\.” You should now be ready to code. Proceed to page two.
Primary Document Selection Drop-Down Box

Button to Open Code Manager Window

Atlas.ti Coding Software Screen Shot
Examples
From I25P1C3

D: What caused you to intervene in your own way of acting? Was there a specific exchange of messages, or do you remember a particular failure?

L: I don't remember a particular failure. I mean, after a while, you know, {"Hey, you're not answering my phone call," but he'll respond to my instant message.}

Coding this passage: The leader, L, recognized that one technology was not working and that another one was working. This is an implied action. There is not an explicit verb phrase from L indicating what he did, so it cannot be coded as an action. It is a trigger, a cause of action. The section indicated by the brackets {} should be coded as a Structural Trigger: indicator A.

From I25P3C5

D: Reflecting on this experience, would you have done anything differently? Or, are you going to do something differently?

L: The one thing I'm going to do differently, is ask somebody to create a team list that everybody can import to accelerate the uptake of using it.

D: And the ease too.

L: Yeah, because, "What's your ID? What's yours? What's yours?"

That's kind of a pain. So, with the list done it will be easy,
**Coding this passage:** The leader, L, reports actions he expects to take. These are still hypothetical. They should not be coded as actions. There is no code to apply.

**From I26P2C3**

D: What did you have to do to get that simulation software working?

The client vendor took you for two days right?

L: Yep. First of all, {we gave him the two screens that we had developed}, and he said, “Well, ok, let me build those.” And he said, “Now, how do you want these to relate and what do you want these selections to be? If you... what do you want to sort?” We knew we wanted to sort, but we didn’t know that we wanted an embedded sort, like, sort this one first and then within that sort this one. We hadn’t thought about that. We also hadn’t thought about some of the other selections that would happen. So, what we did was, {we talked through it with this guy}. First of all, {he built our screens}, and he said. “Ok. If I click this, what do you want to happen?” And then he would make it occur. So, {we sat through first, with an initial build of it, and then, enhancing our requirements to make it function better.} And then, {what we also did, because it’s a simulation, we had to provide for him JPEGs of logos so it would look better}. So that it would look real. As well as, if clicking a certain option would open a certain legacy application, screen shots and demos of those so that he could embed them in there. So when you click this button, you go to this
application. Now you can go use this one and do whatever you need to do. So, that was the kind of stuff {we worked with him} on.

**Coding this passage:** The leader reports what she did in getting the information tool to work. In this case, all of the behaviors should be coded as actions as captured in the brackets {}. Where the verb phrase begins with “we” the indicator is A, action perpetrated by the interviewee. The other one, “he built our screens,” is indicator B.

**From I27P2C5**

D: So what you did was {you just talked to everybody and said, “Here are the benefits. Here’s what we’re doing. We need to use CVS.”

L: Yes.

D: You did that by email or did you call a telecon?

L: Email and videocons.} Well, the had CVS previously from the archive. They had space for it. They even were using CVS for small parts of the project. They were reluctant to expand use to the whole project. So, I brought that to the table. I basically said, “Look, you’re only doing a small part of the project [in the CVS]. It’s not useful to do just this one bit. We should cover the entire project. In fact the areas where we most heavily overlap are not in CVS now. That needs to be brought in. And we need our data, a test suite of data that we all agree should be tested, should go in the CVS.”

**Coding this passage:** The leader tries to reproduce exactly what he said to his team. The behavior is the important part. It is captured in the idea that he did talk to his team and try to
convince them. The leader does not say this directly but agrees with the interviewer’s summary.

This summary is a Leader Action: indicator A as captured in the brackets {}.
APPENDIX K: SHORT SUMMARIES OF CRITICAL INCIDENTS

<table>
<thead>
<tr>
<th>ID</th>
<th>Reference Name</th>
<th>Result</th>
<th>Stage</th>
<th>View</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>I22P1C1</td>
<td>CVS use faithfulness</td>
<td>Effective</td>
<td>Late</td>
<td>Facilitator</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>One team member fails to update shared information, leading to multiple failed interdependencies discovered at a status check-point. Leader brings social pressure to get person to comply from then on. Effective.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I22P2C2</td>
<td>Document Version &quot;Sneaker Net&quot;</td>
<td>Both</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2+ weeks</td>
</tr>
<tr>
<td></td>
<td>Document versions got out of control, causing rework and poor sharing. Work was behind schedule. Members were not responding virtually. They &quot;went dark.&quot; Leader called collocated meeting in which file versioning could be physically controlled. Productivity improved for that stage, but lasting change did not take place—reverted to old structure later.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I22P2C3</td>
<td>Expert goes &quot;dark&quot;</td>
<td>Ineffective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
<tr>
<td></td>
<td>Team member stops cooperating by opening direct connections to client. Leader escalates pressure to enforce cooperation. Team member escalates resistance. Leader gets kicked off the team.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I22P3C4</td>
<td>eMtg Expanded Use</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>2-4 hours</td>
</tr>
<tr>
<td></td>
<td>Conflict arises between client and consultant during work over information produced by consultant. Leader gets consultant group to immediately walk client through logic, using interactive eMeeting they had been using internally. Client changes mind and project work continues. Very effective.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I23P1C1</td>
<td>Japan Email</td>
<td>Effective</td>
<td>Middle</td>
<td>Facilitator</td>
<td>1 week</td>
</tr>
</tbody>
</table>
Remote group escalates issue due to misunderstanding from email. Leader responds to escalation pressure by rearranging schedule to enable more frequent telecons and emphasizes more shared repository use. Effective.

I23P1C2  MS Project  Effective  Late  Facilitator  1 week
Leader hired to improve project. Finds that status accountability is poor due to poor use of management tool. Emphasizes better use of Microsoft Project and enforces additional features. Status tracking improves. Effective.

I23P2C3  Status Visibility  Both  Late  Facilitator  1 week
Overall project management was failing. Leader tried eMeetings and shared repository to improve status tracking and work progress. Seeing failure, high-jacked the project—called FtF meeting, reassigned other managers, and micro-managed them. Initial facilitation failed, project was saved at high cost.

I25P1C1  Teamroom Groupware  Ineffective  Early  Facilitator  3-4 weeks
Leader sets up project with extended teamware suite. Team does not use it. Other co-leader is not on board and becomes big detractor. Work does not improve. Leader time lost. Ineffective.

I25P1C3  Springboard IM  Both  Start-up  Facilitator  1 day
Leader has trouble getting one subgroup to participate and respond using telephone and email. He notices they use instant messaging internally and installs it to work with them. They respond to his instant messages. Work is enabled, but the quality is not good. Mixed result—gets them through stage but leads to re-work later.

I25P1C4  Calendaring  Effective  Early  Facilitator  1 week
Big project. Scheduling problems arose. Leader had 2 Consultant groups install client's calendaring software to enable scheduling. Frustration decreased and work efficiency rose. Very effective.

I25P2C2  Collaboration Portal  Effective  Late  Facilitator  3 weeks
Teamroom was failing. Leader has team member research and setup a shared teamroom not attached to client or consultant. Interaction problems decline. Frustration levels improve. Very effective.

I25P3C5  IM integration  Both  Early  Facilitator  6 weeks
Leader recommended client install and use IM to help mitigate dispersed team risk. Some installed and started using successfully, many had technical trouble and have not been able to use it. Mixed result.

I26P1C1  eMtg Demo  Effective  Early  Facilitator  1 week
Consultants acquired and used eMeeting tool to include many members without overwhelming client at critical meeting. Project manager participated remotely and benefited from being remote. Very effective.

I26P1C4  "Cruisers"  Both  Start-up  Member  5 days
Someone suggests USB drives as solution to on-going network problems for file exchange. Leader gets one, encourages others, discusses use norms and work improves.

I26P2C2  Telecom Protocol  Effective  Start-up  Facilitator  2 months
First meeting revealed whispering during telecon- improper cooperation between technical and business groups. Leader physically moves self to be with the technical side so that others do not gang up on or act rude to the remote site during virtual interactions. Trust develops over 2 months. Very effective.
Application Simulation Effective Late Facilitator 2 weeks Demo

Client suggests simulation software. Consultant tries it, stopping work for two days to train and develop this additional task then delivers a working simulation. Big success. Alleviated concerns about whether and how the software would work. Very effective.

UML tool Ineffective Middle Facilitator 2-3 weeks

Leader suggested UML tool that would improve members' knowledge of standards and ability to exchange rich information. Setup proved insurmountable. No benefit gained. Ineffective.

Threaded Email Flaming Both Middle Member 6 months

Interviewee tried using the threaded discussion, but one member became upset and flamed him publicly on the discussion. This led to a work cooperation breakdown. Management escalation and attempts at direct communication failed to improve tool use. Interviewee learned about intercultural work and had to ultimately fly to meet the French individual collocated. Cooperation improved. Effective but costly.

Email Repository Ineffective Middle Facilitator 2 months

Leader joins ailing project and runs into problem getting oriented due to information being dispersed (not findable). Suggests improvements (use of shared email archive) informally, but lacks enough authority to make structural change. No change. Problems persist. Ineffective.

Message Labeling [Flagging] Effective Middle Member 2 months

Email overload caused inefficiency. Leader and others decided to change email use pattern to help readers filter message content with labeling. Some use some don't. Partially effective.
Leader joined project and had huge problem locating necessary files and information. Others had similar problems. Leader suggests increased use of CVS tool. Members see benefit (had been using tool in a few places already) and begin very quickly. Efficiency and productivity increase substantially. Very effective.

Leader frustration at trouble handling conference calls built. He mandated new tool that would be simpler for him. Use was simple and conformed to ways of using existing tool. People switched. His frustration decreased. Effective.

Leader assigned team member to research and implement a WIKI. Training happened collocated with technical team members between project phases. Work productivity and accountability improved. Process documents are findable and up-to-date. Very effective.

Inappropriate posts to the WIKI under fake logins became too inappropriate. Leaders talked and top leader set a new policy sanctioning such behavior in the future. The inappropriate posts ended.

Leader designed a feature to make the workflow system produce instant reports for schedule viewing and forecasting. Members began to use it. It saved time.
Leader entered a team that had been using an eMeeting tool from time to time. He began calling eMeetings almost immediately to handle work that was behind and had previously been done other ways. Very effective.

I29P1C2  Intercompany Process   Effective   Middle   Facilitator   2-3 days
Leader came to fix project. Established leads group (changing roles, task and tech) that met and handled all inter-group communication using a shared discussion repository where each groups information is visible. Check point did not go well, but could be handled in 3 days rather than 2 weeks of down time. (Sign of major improvement.)

I29P2C3  Email Repository   Both   Early   Facilitator   2+
months
Leader implemented email repository. Team resisted, but leader insisted, thinking of the future stages of the project. Leader ends up doing most of the updating. Mixed result.

I30P1C1  Proj. Mgmt. Tools   Effective   Middle   Facilitator   2 weeks
Leader arrived, observed poor tracking and no follow up to critical issues. Instituted a tracking Excel spreadsheet and shared it. Once it had content he had added by listening in mtgs, assigned others to use it. It became popular and issues started to be tracked and completed.

I30P2C2  Screen Sharing   Effective   Middle   Facilitator   2-3 days
Leader frustration rose because team members had different ICT versions, causing miscommunication and delays. Leader institutes eMeetings using screen sharing for immediate co-editing and signoff of documents, speeding up the process dramatically.
Individuals had used tool before, team had not. Very effective.

I30P3C3  File Sharing   Effective   Middle   Facilitator   1 day
A 48 MB file could not be exchanged. Leader sets up a Web file server on his home system, corporate ICTs exist but have inadequate capacity. Client even asks to use his server for other tasks. Very effective.

I31P1C1 MS Proj./ Excel Effective Late Member 2-3 weeks

Leader tried to institute Microsoft Project, a new technology for him, for task tracking. It failed. He reverted team to Excel, which some had been using already. This worked well. The facilitated move to Project failed. Excel was effective.

I31P1C2 New Page Design Ineffective Middle Facilitator 2-3 weeks

Leader and client had simple task. Conflict arose and leader could not justify answer to client virtually. Additional virtual resources were needed, perhaps a common repository with a document clearly delineating scope. Leader had to travel to client to resolve issue. Very ineffective.

I31P2C3 Screen Sharing Attempt Ineffective Early Facilitator 1 day

Leader tried to get others onto screen sharing, but installation and configuration difficulties along with bias against consultant stopped effective appropriation. This later impacted attempt to use other alternate ICTs. Very ineffective.

I31P2C4 IM attempt: failed Ineffective Early Facilitator 1 week

Leader tries to get others onto IM but others don't have the shared idea for IM use. They directly state preference for phone. They don't see the benefit even though leader explains need in this virtual context. They do not appropriate, and no efficiency is gained. Leader time lost. Ineffective.
Leader found client member using instant messaging (IM). Started using with that member, then one-by-one got other members on board. Original client user was example of use, trained others, and championed the tool in client group. Very effective.

Two groups in different locations have different conceptions of how to use email. This is causing a communication and cooperation problem. Leader takes action to improve communication with email and adds IM. Effective.

A talented person on the team is discovered, and leader finds ways to increase his participation/input using ICT and other means.

Leader developed a culture of information sharing in which people accurately filter for each other to avoid overload. He did this by modeling the CCing behavior in Email. Effective.

Leader delegated OO tool deployment to one guy. He lacked background. Tools did not get implemented. Bad habits formed in absence. New person hired to setup tools and get running. Hardware, network and software problems arose. Months later, OO tools are up and running, some of the value is seen, but much remains being done along the habits formed in the absence of the collaborative OO tools. Mostly ineffective.

Email did not have capacity and handshake to ensure document transfer. Leader got FTP server setup, along with a process for archiving old files. Communication became easier. It
becamse the "cornerstone" of the project's success. Tremendous success. Used on later projects too.

I34P2C2 3 Custom Report Tools Effective Early Facilitator 2+ months

High pressure Y2K project software factory needed to process a lot of files and update them, some custom, some not custom. Leader decided to make tools that could automate parts of the work as well as the information gathering that enabled the process and client billing at a distance. Huge success.

I34P3C3 VPN Failure Ineffective Middle Facilitator 3 days

VPN did not enable remote location to adequately alpha test code due to bandwidth inadequacy. Leader could not solve problem with ICT due to policy and cost. Very tight schedule. Moved person from remote location to near client to be able to test. Rearranged other task and role elements, and project was able to complete. ICT facilitation failure, project success.

I34P4C4 Remote Logins Permissions Ineffective Early Facilitator 3 days

Project was setup for remote testing and login, but client policy restrictions disabled ability to adequately test using VPN. Discovered this once work had begun. No ICT performance issue, but had to move person to client site, rearrange task on the fly and reassign roles to add additional testing. High pressure and time constraint. Project worked, but ICT failed.

I35P1C1 Self-Governing Facility Effective Start-up Facilitator 2 weeks

Email, system access, and phone "comfort technology" were inadequate in establishing a self-governing facility to outsource IT functions. People were not using them enough. Leader adds more FtF time to project. IM blocked by client. Not having versioning software
is a problem. FtF solution. Costly, but effective. Large project. One aspect of comfort ICT use was that many people were new and could not be expected to know more advanced ICT or company norms - had to "level the playing field" for them.

I35P2C2 Creative/IT Communication Effective Middle Facilitator 2-3 weeks

Creative side and IT side sat in same room but were virtual. Very aggressive time schedule. Creative side was not producing deliverables, causing delays in IT side production. Leader makes shared Excel spreadsheets for task, retrains whole creative side, requires daily updates, prints and posts each individual's status on shared whiteboard. This new process leads to morale decline but project completion. Effective.

I35P3C3 Audio Conf. Force Handling Effective Early Facilitator 3 months

In outsourcing arrangement, legacy staff refused to communicate and conflict arose. Leader forced groups into audio conferences with each other to resolve issues. They had been using audio conferencing. Very effective.

I35P3C4 Security Policy Change Effective Middle Facilitator a week

Leader recognized that IT consultant could not test code well in outsourcing arrangement. Project in trouble. Leader promoted to help. Decided to mandate equal treatment of outsourcers as in-house consultants for system access and permissions purposes (changed policy). Outsourcer problems disappeared, productivity improved. Very effective.

I36P1C1 Logging DB Feature Effective Middle Facilitator 2 weeks

Leader brought in to fix project. Based on experience, leader mandated creation of logging function in realtime system software product to analyze bugs. She built a tool to do it, assigned roles, and arranged it as part of the task. Logging feature became critical for client
to communicate to development team what was going wrong and to find problems with other vendors' systems. Very effective.

I36P1C2  Occasional Conference Call  Effective  Late  Facilitator  1 day
Leader had instituted weekly status calls early-on with the client then expanded them to include ad hoc problem resolution once first delivery was made. Very effective. Saved a lot of time.

I36P2C3  Live Data Stream  Effective  Middle  Facilitator  1 week
Leader brought in by one group to threaten IT group in same org. Leader finds IT blocking critical information collection for system improvement purposes, cannot get cooperation, sneaks behind IT's back and installs a automatic data FTP tool that enables the task for the other internal group and external system development company. Very effective.

I36P2C4  Excel Spreadsheet  Effective  Middle  Facilitator  1 week
Leader brought in by one group to threaten IT group in same org. Leader finds IT blocking critical information collection for system improvement purposes, cannot get cooperation, sneaks behind IT's back and installs a custom-coded tool that aggregates and summarizes key realtime data for system testing that enables the task for the other internal group and external system development company. Very effective.
APPENDIX L: CODING STAGE 2: SPLITTING

First, all codes quotations are imported and shown on the sorting board in Atlas.Ti 5.
Gradually, unwanted links are removed and associated quotations are assigned to the new codes, moving them under their new grouping.
Finally, the codes and quotations are sorted into their new groups.
APPENDIX M: CODING STAGE 2: CODE-QUOTE ANALYSIS

Code: Confront unacceptable use {3-4}

P66: Action_Quotes.rtf - 66:55 [L: He was continuing to do that, even though basically I wrote to him after the second incident to him and to the team leader. I said that I think that this is completely unprofessional. There’s no room for you to call me… I forget when he did this, perhaps the second time, when he called me, “Professor Dimwittle.” I mean, that’s totally out of control.]

Codes: [Apply (escalate) Management Pressure to Support Faithful Use] [Confront unacceptable use]

L: He was continuing to do that, even though basically I wrote to him after the second incident to him and to the team leader. I said that I think that this is completely unprofessional. There’s no room for you to call me… I forget when he did this, perhaps the second time, when he called me, “Professor Dimwittle.” I mean, that’s totally out of control.

P66: Action_Quotes.rtf - 66:64 [L: [Duplicated from incident a..] (640:657) (dominict)]

Codes: [Apply (escalate) Management Pressure to Support Faithful Use] [Apply Social Pressure to Support Faithful Use] [Confront unacceptable use] [Develop consensus that there is an ICT problem] [Recognize unacceptable use] [Sanction unacceptable use]

L: [Duplicated from incident above due to dual relevance.] One of the issues we had was people posting humorous and semi-inappropriate things under fake logins. They had the ability to go and create their own logins. So they would create one and post stuff that wasn’t entirely appropriate. We cracked down on that. It was partially the COO sending out a message saying, “Look. Try and be professional about this. We need to make sure that we’re not going to put
anything up there that would offend anybody.” And. We may have disabled the ability to go and create your own login. That may be the extent. So, it’s like, if you want to post, you have to use your own login.

Codes: [Action] [New Techology Structure]
No memos

D: And who noticed that? I guess you noticed it.

L: I noticed it. The person who cracked down on this was the COO.

D: Now, were you party to that discussion with the COO on how to crack down on it?

L: Yeah, I commented. He sent emails around about it. I mentioned that I agreed that I thought that was inappropriate, and that’s what he did.

D: So, one part of it sounds like it was sending out a message to the whole company or to everyone using the tool not to do the behavior, not to post the off-color humor. Another side of it sounds like disabling the fake name registration. Is that right?

L: Sorry, I’m looking to see… sorry to mess up the incident. It looks like it does not actually prohibit you from creating a fake name, but now there’s the understanding that you shouldn’t do it. And, since he sent that email, nobody has.

D: Ok. So, it was a policy.

L: So, the developer who is the administrator for it [the WIKI] deleted the fake accounts and cleaned up some of the inappropriate postings, and then the COO sent the message saying that use of the WIKI needs to be appropriate and whatever you post has to be under your true
login. Then, something along the lines that if you use somebody else’s login to create a posting it would be considered just as bad as sending email through somebody else’s account.

D: Ok, so that’s a kind of sanction really.

L: yes

L: Yeah, we were coming up with wider principles that we would live by, and one of the manifestations whether we were living by them would be our written correspondence. It wouldn’t be the only one. There would be verbal correspondence, but we were able to use those examples. They had their examples too. It wasn’t just a one-way street. So, we were able to use some examples of what we didn’t like. So the principle would be, if you don’t like what someone’s doing, we’ll tell each other. We’re all about clarity. We’re not going to make general comments. We’re going to focus on clarity. We embrace disagreement, but it has to be over issues and not personalities. Those types of things.

D: Ok. So, it sounds like you setup a kind of adjudication process for dealing with these communications in some alternate format.

L: Yeah. One of my guys I like to read is Chris Argyris, and he talks about undiscussables in organizations. So, we tried to take some things that perhaps were going to
become undiscussable and make them discussable to see if we could come to a clear agreement about what we had learned from those things and what we were going to do moving forward

Code: Create common repository / knowledge base {4-4}


Codes: [Create common repository / knowledge base]

P28: I29P2C3.doc - 28:3 [L; Well, no, not necessarily p..] (6:6) (dominict)

Codes: [Action]

No memos

L; Well, no, not necessarily personal, because what I normally do is most of the emails that are directly related to an issue or project, I cut and paste them in a common repository related to that issue and normally that’s in a common database. So, it’s an issue of going to the issue log in the database and getting all of those emails. Now, I was not 100 percent perfect, and I had a couple of emails I had not copied, which had been toward the later dates of that [communication], and I had those in my email also. Because, normally, I keep my emails. I rarely delete any email. So, what was missing there, I could get it from my email and then later on cut and paste it in the common repository.


Codes: [Create common repository / knowledge base]
Even though I am contacting and archiving my email more, I’m not doing it enough still in my opinion.

P66: Action_Qoutes.rtf - 66:99 [So, we created a directory jus..] (1203:1211)  (dominict)

    Codes:  [Create common repository / knowledge base] [Establish Task/ICT temporal rhythm for use] [Rearrange task to accomodate ICT capability] [Setup ICT for use]

    So, we created a directory just for the project, and we created an inbound directory and an outbound directory from our perspective. So inbound would be the files that they’re sending to us, the code, the design documents, any of their questions, and they copy into that directory. Every morning we pick up and we process that. If there’s any reason to respond to that, we put in the outbound the requirements, the suggestions, and any other feedback. So, we kind of created a kind of very crude workflow to manage the communication of the files. But that may not have much of a relevance in the current world because the technology has grown a lot,… the email capacity to send larger files, but we still use that FTP technology in many cases.

P41: I34P1C1.doc - 41:3 [L: Right, So this really worke..] (6:6)  (dominict)

    Codes:  [Action] [New Techology Structure] [Structural Trigger]

    No memos
L: Right, So this really worked out well for us, because this also had some self-discipline in the process itself. We also created-along with these directories- we also created an archive directory. So, once we consumed the data or consumed the file, we would remove it from that directory and move it to the archive directory so the other side knows that the person has picked up the file, because you know, with the time difference [to India from the US] we tried to have a daily call, but sometimes, a lot of the information won’t get covered in that, and we don’t want to depend on the call to figure out if somebody has consumed the file or not. So, we made sure that they send us some feedback, even if there’s an empty file saying, “There’s no question today.” They are supposed to copy a Word document with the questions or say “no questions today.” So, we know that they took our file. They consumed the information. Either they are still in the process of consuming our information or they are done and this is the final question they have.

P66: Action_Quotes.rtf - 66:113 [D: Clicking the box, so what d..] (1412:1438) (dominict)

Codes: [Apply positional authority pressure] [Apply Social Pressure to Support Faithful Use] [Create common repository / knowledge base] [Mandate ICT norm]

D: Clicking the box, so what do you mean there? They were going into a shared file?

L: In Excel, yeah. Updating the matrix.

D: And saying, “I did this today.”

L: Yeah, and adding comments to it. Daily, we would stand in front of them and say, “You marked these three assets off. Let’s see them. Are they reviewed? You’re supposed to
have this asset done. What’s going on? Well, it looks like you’re going to be working Saturday.”

D: So, it sounds like you’re using Excel to do the low-level project management.

L: Yeah, we used it as a “Done-this” matrix. Done these steps.

D: Yeah, how about that.

P46: I35P2C2.doc - 46:6 [L: We’d blow those up into arc..] (16:22) (dominict)

Codes: [Action] [New Techology Structure]

No memos

L: We’d blow those up into architectural size prints and plaster them to the wall.

D: Who had the Excel spreadsheet? I mean, did they have to physically go and cross it off of the wall spreadsheet?

L: Sometimes, they would have to physically cross it off the wall, and sometimes they would have to go in and update it in the file.

D: Ok. And where was the file?

L: In a repository, shared.

D: Ok. So they could do it from their own computer.

L: Oh, absolutely.

P46: I35P2C2.doc - 46:10 [L; I think the change is the d..] (36:36) (dominict)
L; I think the change is the diligence with which we applied it. They were given some latitude, and then we said, basically, “Hold on a minute. There’s certain principles, and this is a good tool. I’m sorry you don’t like it, but this is the way it’s going to be.” What it also did is it took the subjectivity out of progress. We basically got to the point instead of saying, “You’re really behind. You need to work this weekend. You need to catch up” to “you were supposed to get these twenty things done. Here’s Friday. You got these ten things done. What’s that tell you? I’ll tell you what it tells me. You’re not going into next week with a ten-thing backlog. So, you need to figure out how to get caught up.”

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Code: Create Formal Use Norm Documentation \{1-2\}

P66: Action Quotes.rtf - 66:29 [L: We actually prepared a docu..] (278:278) (dominict)

L: We actually prepared a document of what this was, how to use it. And, we had, actually, one person who controlled the setup. So, it didn’t spiral out of control so that it became unusable. And, they were responsible for administrating. They also administrated the user IDs. And they were available as a contact to help anybody.
APPENDIX N: STRUCTURAL TRIGGER THEME CODES

1. A tool feature was needed but missing
2. A tool solution was readily available
3. Clear preference or capability on one tool or another
4. Client requested that team use a new tool to try it out
5. Cost as choice factor in tool selection or usage
6. Email needed different team use standard due to team size
7. Email overload, too many
8. Email unable to handle conflict resolution between individuals in different work groups
9. Email was unable to keep track of different document/code versions
10. Existing tools not interoperable / interconnected
11. File sharing not possible with existing tool(s)
12. Had to work across multiple organizations
13. Individual work product accountability needed improvement
14. Key team members had inadequate knowledge of the tool
15. Lack of trust in professional skills between individuals in different groups
16. Leader could change self without changing others
17. Leader experience (knowledge) of better tool
18. Leader hired to enable change
19. Leader needed synchronous meeting tool with visual control and audio feedback
20. Leader noticed that communication was not working
21. Leader promoted to enable change
22. Leader thought that using different tool would be more effective
23. Leader thought using tool(s) differently would be more effective
24. Members were physically distant from one another
25. Multiple team member locations
26. Need to share information between sub-groups better
27. Needed to enable multi-tasking and member accessibility
28. Needed verbal channel
29. Needed visual control of other's screens
30. No common repository / shared information space existed
31. No regular communication/ interaction
32. One group shirks responsibility to another due to interaction difficulty
33. One or more team members didn't respond, went dark
34. Opportunity to share information between team groups better
35. Opportunity to upgrade tool at team startup
36. Organizational policy restricted tool choice and usage
37. People couldn’t be corralled / convinced using existing tools
38. People were not using the tools properly / professionally
39. Members of different groups had conflicting data and opinions
40. Problem delegation tried previously but unsuccessful
41. Entrenched work habits among one or more groups
42. Escalation of work performance problems cause higher management pressure on leader to affect change
43. Failure to follow procedures
44. Team members had interpersonal conflict/ lack of trust/ relations problems
45. Lack of cooperation
46. Team members' lack of experience
47. Language / Cultural misunderstanding
48. Private communications among team members disabled collaboration
49. Team size bigger than usual tools and ways of using them could handle
50. Thought leader/ tool champion in other group existed
51. Permissions / Access problem
52. Possibilities of a new technology enticed leader
53. Resources available to make change
54. Some team members had not used the new tool before
55. Team size grew
56. Needed ability to control presentation of information
57. Project timeline/ production constraints
58. Project delays created ripple effect / rework
59. Clear evidence visible to all that current tool(s)/ way(s) of interacting were not working
60. Inability to coordinate
61. Information could not be found
62. Information could not be shared
63. Information could not be synthesized to create shared viewpoint
64. Information was inaccurate
65. Task needs changed as project developed
66. Opportunity to improve on way(s) of interacting
67. Pressure to complete this project right

68. Project status not accessible / visible enough

69. Task status not adequately tracked

70. Status "red": deadlines missed, budget overrun, etc.

71. The product release failed the test/ quality control

72. Time differences among members disable an option

73. Time pressure / lack of time to complete task/ project

74. Team member shared knowledge of better tool

75. Team members had different versions of tool(s)

76. Team members had inadequate task knowledge

77. Team members had to multitask (not solely assigned to this project)

78. Team members using tool features in an unacceptable way

79. Tool assigned but not getting used

80. Tool features poorly designed / inefficient

81. Tool not accessible and/or reliable enough

82. Tool poorly implemented/ configured
APPENDIX O: LEADER ACTION THEME CODES

1. Accepts tool improvement suggestion from team member
2. Adds a new tool
3. Adds a tool to enable new task
4. Adds a tool to enable participation
5. Adds a synchronous voice communication tool
6. Allows use of "comfort tools" instead of mandated tools
7. Escalates issue to apply higher management pressure
8. Uses positional authority to force change
9. Applies social pressure (shame, guilt) to support use compliance
10. Assigns one person to administer complex tool being added
11. Blocks use of alternate tool
12. Changes team member's role
13. Modifies team communication policy
14. Commits initial use of new tool
15. Conditions team to expect tool changes during project
16. Confronts unacceptable use
17. Creates common repository / knowledge base
18. Creates formal tool use norm documentation
19. Delegates technology facilitation tasks to team members
20. Designs communication using comfort tool(s)
21. Designs complex tool use to minimize organizational barriers must be crossed
22. Designs tool(s) into initial project communication plan
23. Designs project with extra resources to handle problems
24. Develops consensus that benefit of tool(s) outweighs effort to learn/use
25. Develops consensus that there is a problem with a tool or the way it is used
26. Discovers working interaction method/tool within non-interacting subgroup and adds it to team
27. Convinces members to use tool(s) through discussion
28. Discusses tool use with team to establish use policy
29. Trains members on new tool co-located
30. Emphasizes use of existing tool(s)
31. Encourages tool use
32. Encourages open communication
33. Establishes regular communication pattern/ expectation
34. Expands use of existing tool(s)
35. Finds better tool and adds it
36. Finds tool to fill a task need and adds it
37. Finds reason for problem
38. Gets other team leaders on board
39. Gets permissions / access arranged
40. Personally installs and uses interoperable tool(s) to match others' tool(s)
41. Learns new tool
42. Makes tool more accessible
43. Mandates way of interacting/ using tool
44. Monitors tool use to assess quality
45. Moves people to reduce use of complex tool

46. Pilots tests new tool before using for real project work

47. Programs (makes) new feature / tool

48. Rearranges people to accommodate tool capability

49. Rearranges schedule to accommodate synchronous tool use

50. Rearranges task to accommodate tool capability

51. Rearranges task(s) to enable tool use

52. Recognizes a partially appropriated tool whose use could be expanded

53. Recognizes that tool is not working well

54. Recognizes unacceptable use

55. Recommends a better tool at design time

56. Recommends a better tool during interaction

57. Recommends better use of existing tool

58. Reduces virtuality by moving people

59. Reduces virtuality by moving task assignment to other location

60. Reminds members to use tool (common repository)

61. Restricts tool use to minimum users necessary

62. Reconfigures tool to improve use

63. Sanctions unacceptable use

64. Sets up tool(s) for initial use

65. Models desired way of using tool

66. Train team on new tool

67. Reminds member to use/ how to use new tool
68. Uses subgroup user as tool champion to other subgroup members

69. Works around a security policy / implementation
APPENDIX P: STRUCTURAL CHANGE THEME CODES

1. Ability for larger group to participate
2. Ability to find and use previously hidden key information
3. Additional group participation through changed tool use
4. Balance struck between FtF and virtual benefits
5. Better information access and control for one group
6. Better information retrieval capability
7. Better information sharing
8. Centralized shared information resource
9. Cooperation improvements
10. Easier tool used instead of difficult, problematic tool
11. Existing (comfort) tool(s) failed
12. Expands use of existing tool(s)
13. Tool change accentuated group divisions
14. Tool enabled more tasks to be handled at once
15. Increased ability to contact team members
16. Increased ability to get whole task done at once
17. Increased information processing and visualization capability
18. Increased information/process visibility
19. Created authoritative information source and archive
20. Increased synchronous tool use
21. Added one or more communication channels (redundancy increase)
22. New features added to existing tool and used
23. New tool added and change in task use
24. New tool added but no change in task use
25. New tool becomes embedded, applied beyond initial scope
26. New tool enables socializing
27. New tool failed
28. New tool had a bandwidth requirement disabling some participation
29. New tool had a permissions barrier disabling participation
30. New tool interfered with task
31. New tool only partially added due to technical problems for some users
32. Changed way team used existing tool(s)
33. New virtual participation better than old FtF way
34. No change
35. No tool added or removed
36. Poor follow through - tool not fully used
37. Increased participation
38. Participation of critical member enabled
39. Participation structured around subgroups to filter information
40. Problem member begins to use tool appropriately
41. Physical accessibility issue emerged as FtF reliance increased
42. Leader relocated self to weak group to increase virtual communication fairness
43. Policy change enabled tool addition/ use (organizational)
44. Reduced virtuality to zero (moved or removed people and/or tasks)
45. Increased structured participation
46. Synchronous presentation and feedback ability added

47. Task automated in tool

48. Task change accompanied by tool change

49. Team roles rearranged

50. Tightly controlled tool use instituted

51. Increased voice tool usage

52. Work assignments altered
APPENDIX Q: TEAM OUTCOME THEME CODES

1. Accountability of individual improved
2. Accountability of group increased
3. Budget exceeded
4. Efficiency improved after initial investment
5. Built client confidence and excitement
6. Client fear reduced
7. Client satisfaction declined
8. Client satisfaction increased
9. Communication became more frequent
10. Communication easier (timely, less overhead)
11. Communication efficiency improved
12. Communication improved
13. Communication was more effective
14. Communication was more timely
15. Cooperation declined
16. Cooperation improved
17. Coordination became more difficult
18. Coordination got easier
19. Coordination improved
20. Coordination time saved
21. Cost overrun avoided
22. Costs escalated
23. Deadline for delivery made
24. Deadline for delivery missed
25. Decision accuracy improved
26. Disorganization impacts next project/phase
27. Efficiency gained
28. Efficiency lost
29. Efficiency not gained
30. embarrassed one user
31. Enabled project completion
32. enabled project progress
33. enabled work that was otherwise unworkable
34. Enabled work to continue
35. Frustration levels decreased
36. Frustration levels increased
37. Group information asymmetry reduced
38. Facilitated tool use attributed as primary cause of project outcome
39. Improved outcome
40. Inaccuracies impact next project/phase
41. Incomplete deliverables
42. Information accessibility improved
43. Information accuracy declined
44. Information accuracy improved
45. Information and decision accuracy trusted
46. Information capture and permanency improved
47. Information complexity increased (for team members)
48. Information coordination improved
49. Information exchange accuracy declined
50. Information exchange accuracy did not improve
51. Information exchange accuracy improved
52. Information exchange became possible
53. Information exchange ease did not improve
54. Information exchange volume improved
55. Information filtering by group improved
56. Information quality did not improve
57. Information quality improved
58. Information sharing improved
59. Ability to manage tasks improved
60. Leader demotivated
61. Leader removed
62. Leader wasted time
63. Lesson learned (failure) impacted other improvement attempts
64. Lesson learned and made into organizational policy
65. Lesson learned by group and reused
66. Lesson learned by individual and reused
67. meetings were definitely more effective
68. Missed milestones avoided
69. Morale declined
70. Morale improved
71. Morale loss avoided
72. Overhead requirements relaxed due to increased inter-group trust
73. Participation between groups expanded
74. Participation expanded
75. Process awareness improved
76. Product delivered complete
77. Product delivered incomplete
78. Product delivered on time
79. Product improved
80. Product quality declined
81. Product quality improved
82. Project failure averted
83. Relationship(s) among team members improved
84. Reversion to previous tool use structure
85. Rework avoided
86. Rework required
87. Risk mitigated
88. Short-term ineffective, long-term effective
89. Snowball effect - negative
90. Snowball effect avoided
91. Stress avoided
92. Task automated / standardized
93. Task fully accomplished
94. Time and money saved
95. Time loss due to complex IT avoided
96. Time lost
97. Time saved
98. Timeliness improved
99. Trust between groups declined
100. Trust between groups improved
101. Trust improved globally
APPENDIX R: MENTAL MODEL BELIEFS THEME CODES

1. "Let them get burned" - motivates appropriation but costs time and possibly more grave consequences.
2. Americans are very blunt.
3. Team members from the Asia-Pacific area need to see sincerity.
4. Team members from Asia and Europe are resistant to criticizing.
5. Be sensitive about high-jacking a project.
6. Believe your client when confronted.
7. Cell phones are unreliable, batteries die.
8. Cell phone reception is unreliable.
9. Client and team leader should be collocated for primary interactions.
10. Comfort technologies - email, system access, phone - are easily appropriated.
11. Microsoft Project helps create a common ground for coordination.
12. Cultural and technical axes differentiate team members' ICT use tendencies.
13. Cultural and language barriers supercede technology issues.
14. Delegate technology facilitation if personally don't know about it.
15. Demonstrated need leads to use and agreement to use.
16. Develop co-worker relations - not just "professional".
17. Distributed development skills are different from in-house.
18. Do initial technology training on a set of ICTs.
19. Communicate face to face, if possible, body language drives understanding.
20. Don't cave in to client demands. Validate them.
21. Don't let project management ICT get in the way (especially too sophisticated is
unnecessary).

22. Don't overwhelm people with ICT setup and use requirements.

23. Don't release control of project plan.

24. Email always has problems.

25. Email and PowerPoint are good enough for small-team synchronous meetings.

26. Email between Asia and US is problematic.

27. Email is inappropriate for immediate issues involving cross-group discussion.

28. Email is very reliable but not so quick like the phone.

29. Email is more adequate in small teams.

30. Email repositories help build organizational learning capability.

31. Email repositories increase accountability and message commitment.

32. Email repositories lead to improved ability to cope with turnover.

33. Email is too slow for immediate discussion because concentration train can be broken.

34. EMeetings are better for larger, more disperse teams.

35. Err on the side of too much information sharing. - let people filter it out.

36. Europeans want some socializing.

37. Experience leads to knowledge about what pays off procedurally and commitment to sometimes tedious uses of technology.

38. FtF is critical during formation to setup personal dynamics if overcoming organizational culture differences.

39. FtF enhances focus and demeanor more than phone.

40. FtF is costly, but in larger, more critical projects, it mitigates risk.
41. FTP is better with small teams or few people using it.

42. Get team members to commit to what they say - avoid rework due to misunderstanding or lack of commitment.

43. Get team members to use the ICTs early in the project.

44. Get involved early. Be proactive.

45. A good leader monitors mistakes and analyzes them.

46. A good leader proactively tries new technologies to learn about them.

47. Have an immediate technology that allows you to share visuals / screens.

48. Have empathy.

49. Having a shared information base helps bond a team.

50. Larger projects benefit from more structure.

51. ICT does not change personal core volition / motivation to work.

52. ICT may be left or right brained and a personal fit with user leads to more successful appropriation.

53. ICT used for personal and business purposes is easier to add.

54. If immediate project team can't see need, it's harder to get them to appropriate ICT.

55. If you have a lot of repeat processes, build custom ICTs or features to automate them.

56. IM allowed playfulness due to custom of allowing spelling mistakes: improved intra-team relations.

57. IM is like a virtual water cooler: socializing device.

58. IM can intrude if forgotten (not turned off during a presentation).
59. IM can stop the virtual team ripple effect by enabling reaching decision-makers with simple requests.

60. IM does not help ensure reflection - too quick.

61. IM is good for a quick attention grab.

62. IM is better than phone for quick questions.

63. IM makes people more accessible.

64. IM is no good for long, complex discussion.

65. IM can work like a Post-it note on screen.

66. An information delay, even short, can lead to major problems due to interdependencies.

67. Information sharing points of control in subgroups are helpful to reduce chaos.

68. Interdependence - Everything is an input to something at some point.

69. Facilitating technology use saves time. And, time is money.

70. It's better to deal with conflict when it surfaces.

71. Project managers must know how everything fits together.

72. Large projects need orientations to "level the playing field".

73. Latent ICT knowledge among team members leads to improvement suggestions during interaction.

74. Leaders can motivate appropriation through force of personality.

75. Learning curves drive ICT choice. If it's too hard, it doesn't get chosen.

76. Legacy staff don't favor outsourcing - be ready with change management strategies.

77. Listen and take good notes in an accessible format.
78. Live demonstrations enable understanding new systems best.

79. For large systems, in the long term compiling information about the setup process is critical.

80. Make personal accountability visible.

81. Make progress visible.

82. Microsoft Project is good for high-level project management.

83. Microsoft Project is time-intensive to use.

84. Microsoft Project is too complex on low-level.

85. Microsoft Project is useful for very detailed (complex) project plan.

86. Leaders must know project status, even if failing.

87. Organizational culture norms about ICT use can lead to problems.

88. Organizational culture may dissuade information sharing.

89. Outsourcing requires corporate sponsorship - commitment to no going back.

90. Personal preference drives choice.

91. Phone is better than IM for detailed, immediate issues.

92. Phone lacks structure necessary to ensure a process flow - such as strategy then discussion.

93. Phone may be unreliable in consulting projects due to unpredictable host office accommodations.

94. Phone may not be physically available.

95. Phone may be inaccessible, require a code.

96. Present a mock-up for design work... don't begin with a blank slate question.

97. A project management tool must handle details on the personal level well.
98. Proper preparation prevents poor performance.

99. Real-time systems require alternate test techniques than debugging and typical system techniques.

100. People may appropriate new technology simply because it entices them.

101. People may appropriate technology if they believe it really would be more efficient.

102. Reduce overhead administration burdens when possible. ICT can be a factor.

103. Getting the right information to right person at right time leads to a quality information systems development product.

104. Screen sharing is useful for demonstrating developing capabilities or form.

105. Security and functionality must be balanced in ICT choice and implementation: they're opposed.

106. Share information but target it at relevant groups.

107. Shared ICT toolkit serves as resource for coordinating technology change later if needed.

108. Show benefits when adding an ICT.

109. Some ICT is generally appropriated: requires no training, little technical attention.

110. Some ICT is not generally appropriated: requires technical attention.

111. Some ICT changes are to support future needs that are invisible to the immediate project team.

112. Static representation is second best way to relay understanding of new system concept - after live demonstration.
113. Status visibility increases accountability.
114. Stay calm and try to understand when issues arise.
115. Immediate, person-to-person communications are more effective for conflict resolution.
116. A "task manager" does not keep things whole like a "project manager."
117. Big teams begin at about 12-15 members. Less than that is a small team in terms of ICT use issues.
118. Techies will know more ICTs than non-techies.
119. Technical issues are easier to solve than cultural issues.
120. Teleconferencing and chat work better than email alone in design tasks.
121. Test your ICTs before using them for production work.
122. Text can be misconstrued easily.
123. Archive text messages as much as possible.
124. A combined media (textual-visual-audio) presentation boosts retention for new material.
125. There must be personal accountability in ICT use.
126. There’s always a solution.
127. Tie legacy staff performance to whole engagement performance in outsourcing.
128. A tool's internal business logic can disable work if cumbersome.
129. Train team members most apt to be capable to chauffeur the others.
130. Treat all deliverables equally - art must be on time just like code.
131. In order to build trust as a consultant, be a real person - not a stereotypical consultant.
132. Developing a personal relationship with the client builds trust.

133. Having domain knowledge of client's business builds trust.

134. Use ICT to bring in needed expertise / talent.

135. Video conferencing is problematic.
APPENDIX S: ROUND 3 SORTING TASK

Introduction
This study examines five types of phenomena as they relate to technology facilitation in virtual teams. Technology facilitation is an occasion when a team leader takes action to improve team communication or interaction by improving the team’s information and communication technology (technology) use. The first four phenomena of technology facilitation are sequential. They are (1) structural triggers, (2) leader actions, (3) structural outcomes, and (4) team outcomes. The fifth phenomenon is leader beliefs or mental models. These may affect technology facilitation at any point and are thus separated from the sequential phenomena. The model below may help you conceptualize this relationship.

These phenomena were collected from interview transcripts with virtual team leaders in a coding process. In coding, the wording given by the interviewee may have been changed a bit to make the code and some codes may be almost exactly identical. Coders were allowed to make as many codes as they saw fit.

Definitions

Key Words

Structural Trigger: A structural trigger is a specific condition that existed prior to technology facilitation action(s) being taken, especially those that caused or prompted technology
facilitation. Structural triggers often include ways in which people, tasks, technology, and organizational factors were acting individually or were interacting with each other.

**Leader Action:** A leader action is an action taken by a leader in a technology facilitation incident.

**Structural Outcome:** A structural outcome is the result of (2) leader action. It is usually an emergent way in which technology comes to be used for work by one or more members of the team, but it can also be marked by the absence of a change, especially when technology facilitation fails. Structural outcomes manifest in changes in technology use for work which can be accompanied by changes in people, tasks, and organizational factors, such as roles, work processes, and organizational security policies respectively. All such changes that enable the changed technology use are part of the structural outcome.

**Team Outcome:** A team outcome is the value of the structural outcome for the team, whether in work productivity or some other way. It is indicated by any reported impact on the project, the team members, the team as a whole or the organizations involved attributed to the structural outcome.

**Mental Model Belief:** A mental model belief is a general thought about how people, tasks, technology, or organizations individually behave on their own or interact in combination with each other during virtual team project work. It is distinct from a structural trigger in that it states a general opinion drawn from the interviewee’s experience.

**Acronyms found in the Codes**

ICT = Information and Communication Technology

IM = instant messaging, a type of ICT
Status RED = as in a traffic light metaphor, work has stopped due to problems
b/c = because
FtF = Face-to-face
VT = virtual team
PPT = Microsoft PowerPoint, a software package for presenting information
Telecon = audio conference (telephone conference)
SMM = Shared Mental Model
MS Proj = Microsoft Project, a software package for managing projects
Org = organization, examples being corporations, businesses or agencies

Instructions
1) Choose one of the phenomena to sort.
2) Unbundle one deck of cards (aka “codes”) and mix them up thoroughly on a large table or flat surface where you will have plenty of space to lay them out.
3) Lay out all of the codes face-up so that each is displayed.
4) Begin grouping them according to any patterns you see in the content of the codes (i.e. card size and code length [physical characteristics of the piece of paper] are not important). In other words, find logical groupings of the codes.
5) Your goal is to find 3-7 major themes and 10-20 minor themes within each deck of codes. As a general guideline, any category may have subcategories at your discretion, and a category may consist of a single code.
6) Once you are satisfied with your categories, record your answers on the sorting record sheet.
**Sorting Record Sheet**  
Phenomenon Coded: (Circle One)

<table>
<thead>
<tr>
<th>Structural Triggers</th>
<th>Leader Actions</th>
<th>Structural Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Outcomes</td>
<td>Mental Model Beliefs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Codes (write the numbers from each code card)</th>
<th>Code Group</th>
<th>Description (What is the common thread or theme connecting the codes you have grouped?)</th>
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<tbody>
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</tbody>
</table>

* If there are relationships between categories or larger groupings of categories, write them on this sheet. Draw lines in the margin connecting them or mark as necessary to make the relationships clear. Use additional space on the back of this page if necessary.
APPENDIX T: CODING ROUND 3: SORTING REPORT SAMPLE
Leader Action Codes Coding Report

Apply indirect pressure

26 Applies social pressure (shame, guilt) to support use compliance
133 Escalates issue to apply higher management pressure

Begin use

52 Commits initial use of new tool
379 Personally installs and uses interoperable tool(s) to match others' tool(s)

Change task

411 Rearranges schedule to accommodate synchronous tool use
412 Rearranges task to accommodate tool capability
413 Rearranges task(s) to enable tool use

Confront unacceptable use

61 Confronts unacceptable use
435 Sanctions unacceptable use

Create / modify formal use guideline

76 Creates formal tool use norm documentation
320 Mandates way of interacting/ using tool
332 Modifies team communication policy

Create tool or feature

75 Creates common repository / knowledge base
402 Programs (makes) new feature / tool

Delegate (add tool)

28 Assigns one person to administer complex tool being added
Delegates technology facilitation tasks to team members

Design time

Conditions team to expect tool changes during project
Designs communication using comfort tool(s)
Designs complex tool use to minimize organizational barriers must be crossed
Designs project with extra resources to handle problems
Designs tool(s) into initial project communication plan
Establishes regular communication pattern/ expectation
Recommends a better tool at design time
Restricts tool use to minimum users necessary

Design use

Designs complex tool use to minimize organizational barriers must be crossed

Disable use

Blocks use of alternate tool
Moves people to reduce use of complex tool
Reduces virtuality by moving people

During interaction / project Work

Accepts tool improvement suggestion from team member
Finds reason for problem
Monitors tool use to assess quality
Recognizes that tool is not working well
Recognizes unacceptable use
Recommends a better tool during interaction
Encourage cooperation

129  Encourages open communication

General (add tool)

19   Adds a new tool
20   Adds a synchronous voice communication tool
21   Adds a tool to enable new task

Persuade to change use

92   Develops consensus that benefit of tool(s) outweighs effort to learn/use
93   Develops consensus that there is a problem with a tool or the way it is used
96   Discusses tool use with team to establish use policy
158  Gets other team leaders on board

Persuade to use

63   Convinces members to use tool(s) through discussion
124  Emphasizes use of existing tool(s)
417  Recommends better use of existing tool
428  Reminds members to use tool (common repository)

Re-arrange roles / responsibilities

28   Assigns one person to administer complex tool being added
43   Changes team member's role
84   Delegates technology facilitation tasks to team members
159  Gets permissions / access arranged
410  Rearranges people to accommodate tool capability

Reconfigure tool
319 Makes tool more accessible
420 Reconfigures tool to improve use

Reduce use complexity

28 Assigns one person to administer complex tool being added
86 Designs communication using comfort tool(s)
87 Designs complex tool use to minimize organizational barriers must be crossed
430 Restricts tool use to minimum users necessary

Re-train

427 Reminds member to use/ how to use new tool

Setup and test tool

386 Pilots tests new tool before using for real project work
438 Sets up tool(s) for initial use

Tool search and (any time) Learning

145 Finds better tool and adds it
147 Finds tool to fill a task need and adds it
309 Learns new tool

Train users

501 Train team on new tool
502 Trains members on new tool co-located
APPENDIX U: SAMPLE INTERVIEW TRANSCRIPT (I27)

Project Context One: “QDB” (0:00 -> Recording equipment not started until seventh question)

(initial question is about formal orientation)

L: … previous project manager, that person, she reviewed with them at a high level, what
the tool was intended to do; however, she was missing certain components and members of the
worldwide team.

D: ok

L: and you miss one person out of 50 and that person could come back and become your
Achilles’ heel, because that person could come back and say “I don’t know what you did, but
this tool does not work for my audience which represents 30% of the company’s revenue.”

D: right

L: Hence, now you need at least two, to go back and recapture that. So, there was an
orientation done the first time, and it wasn’t that it wasn’t ineffective in terms of its content. It’s
just that the invitees, the list, was not thorough.

D: Alright, was there a formal wrap-up session at the end?

L: For my part? No… Well, I take that back. When you say wrap-up, do you mean it was
kind of a let’s all shake hands and agree? Because if you do, at the very end of our test cycle,
what we do is we all meet on a teleconference, and we make sure that nobody has any
outstanding issues that would prevent the release from being cutover to production.

D: ok

L: So from that perspective yes, but when I heard wrap-up the first time, sometimes I take
that to mean, as far as a lessons learned debrief, no we didn’t do that.
D: Ok, but there was some sort of wrap-up, it was just more of an error check.

L: Yeah, go-no-go we call it.

D: Who initiated the project?

L: The executive, so our vice president, since he’s the one who funds it.

D: And why? Just in a general sense. You can be as specific as you want.

L: The tool that we actually have is something that lets people register for another tool. That tool is the backbone for all of our customer inform… it’s huge. In other words, 55 million users, and there was no application for users to be able to get into the application, to change their profiles and things like that. There was no way to do it. So, for audit reasons, for usability, for driving adoption, we created the tool the first time. To further that adoption statement, we then went to release 2.0.

D: Did you ever meet face-to-face?

L: No

D: No, ok. What about conference calls?

L: Daily

D: Daily!

L: Yes, we have daily conference calls.

D: With everybody?

L: Well no, they’d be for different things. There are standing calls twice a week where we go with the core leads, the 30 people we spoke of, but all 30 don’t make it, but all 30 are invited to a twice a week call, but there are constantly issues. Or, things that don’t require the whole team’s presence, such as an infrastructure-related call or something very specific that we
try to scale down the invitee list so that we use the people’s time effectively, especially for the
cross-matrixed people.

D: And so that’s sort of the regular daily meetings, but then you have a twice a week
whole team.

L: Right

D: What technologies do you use during those calls? It sounds like you are using the
telephone, is there anything else you are using too?

L: Yes, we’re using eMeeting.

D: ok

L: to do tool demonstrations, or to show something that needs to be looked at by
everyone at the same time. We’re also using like PowerPoint and other Word documents to
share information.

D: Do you have, say, a code repository, that kind of thing?

L: Yes, but we usually don’t hit that during a call.

D: But an eMeeting sort of thing. Was there application sharing in that? L: yes

D: Alright, next one, question 8. What were your internal indicators of project status and
success?

L: We used a Microsoft Project Plan and we just make sure that all tasks were complete
and to date. We use Critical Task measurements. Are you familiar with that term?

D: Yes

L: Ok, so individual tasks, we don’t really care. If they slip then they’ll eventually
become critical path. We use a critical path measurement. So, if critical path were green, even if
we’re behind on tasks, we status it that way. As soon as critical path gets impacted then we move it to a yellow or red status.

D: Ok, and how would you characterize the status at the end?

L: I’d put a 9.

D: OK, so it was very successful.

L: yes

D: Were there any other notable outcomes for the team members, team as a whole, or the organizations?

L: no, I wasn’t really sure what this one meant. I didn’t have anything to say here.

D: Well, sometimes the project may end with significant learning for the organization as a whole. Maybe they’ll learn, in this case you’re dealing with directory services, they might discover a whole new way of dealing with directories and reapply it in other places. So that might be an organizational learning. Or something like that.

L: Ok, so, let’s see how this fits, during the course of development we found opportunities to improve things that weren’t necessarily in scope.

D: right

L: So, we put those things, as long as they didn’t impact schedule and bump them into scope to kind of give an added benefit. So, even though scope was set, the project was set, and the schedule was set, if we have activities that we found along the way, like this code was written in a screwy manner. We could probably re-write it, get better performance. We can probably make this easier for the users, or some defect that had not been noted before, it got missed in testing and production. That did happen. We had about three or four instances of production
fixes we could make that would make the application faster or easier to use that were not a part of scope.

D: right, ok. Was there a specific methodology for this project?

L: See there is one, but I’m not sure if I can share it with you as it’s a piece of company intellectual capital.

D: Could you characterize it in terms of object-oriented, versus structured, versus waterfall, or in some manner that’s more general?

L: Waterfall. (Time : 6:40)

D: Was it mandated?

L: No, not for this project.

D: How strictly did you adhere to it?

L: Very strictly. The thing about our project is that this is one project of dozens that occur at the same time. If you don’t stick to the standardized process that we use to do these kinds of projects for those cross-matrix folks that you work with. If you don’t stick to it, those cross-matrix folks will not know what you are trying to do. They will be part of a process that they don’t understand, and none of them, even if there are better methodologies to do a project with, the reeducation that it would require. That implementation is not worth it.

D: Right.

L: So sticking to the process is not just good because its ravishing, you’re not going to finish without it.

D: Right, that makes sense.
Critical Incident 1: Japan Email (7:39)

D: Ok, so let’s go on to an incident. So we’ve got the project, call it QDBR.2.0 And, what’s the critical incident? I want to know what you did. I imagine yourself back in the incident and I want to know what was the incident and what exactly did you do or say?

L: Ok. The critical incident was this. We had set the scope. We had set the schedules. And everything was good to go. Locked and loaded. And this becomes a lessons learned. It’s now something I live by. In my teams, and the extended teams on the calls, I have some folks on there that are from Japan. They speak English incredibly well. I mean I could never hope to speak a foreign language as well as they do. However, despite whatever you say and however you say it, there’s always a misunderstanding. The missing of the word “not” in their minds could through them off. So, after we had the scope, schedule and everything else to that effect, we started doing our designs, and an issue, without me even knowing it, was escalated that I have taken things out of scope that should not have been taken out of scope. On the call I had verified with everyone that it was ok to take it out of scope and the AP people – Asia-Pacific folks- were ok with me removing it from the scope. It turns out that is not the case.

D: ok

L: They escalated the issue, and we were well past the design phase. We were well into development. They were jumping up and down that these three pieces of scope had to be put into scope. Otherwise they would not sign off on the release, and they would derail it. The problem was I don’t have the ability to move dates around. We scheduled around other projects and we’re scheduled to go into a specific test environment on a set date. I can’t slide that unless I don’t make it that date then the next available date could be four months. So slippage of a day can move me four months. Another reason we stick to a methodology and stick to a project plan and critical path. So, I had to work with the AP team and find out that they really needed this,
and 30 of them, and no funding to get more resources on board. I’ve got to work with the AP team to drop it. So, what I do is there were three pieces of scope. I work with the AP team and the other team members to find out how critical it really was and then go into a series of negotiations for about a week. We were able to negotiate them that we would take two of those pieces of scope, we would promise them to do it at a later time. And one piece of scope we had to just work in parallel. We had to just squeeze it in as best we could.

D: How did that week happen? You say we met with them for a week. Was this a synchronous meeting? Did they fly in?

L: No, everything’s over the phone. Our budget is so constrained that everything requires specific approval and such bureaucracy that it takes you longer to get the approval than it would for you to just hold the call. So, that made it difficult to travel intentionally, they don’t want to spend the money on it, especially going to Japan which would cost $15,000 per person or them coming here, same cost. So, what happened when it got escalated… using email with Asia-Pacific it does not work well. They don’t understand American tone on an email and we don’t understand their’s. Things get taken out of hand and things get out of control quickly. So, during the course of that week, I would meet with them… my first call would be 6 a.m. to discuss what was going on. Then I’d meet with the worldwide team soon thereafter to discuss how it impacts everybody else, all 28 or 29 members. Then I’d meet with my boss to tell him what was going on. We’d work with the QDB development teams to find out what they could accommodate, what we could do during the day, and then at night when Asia-Pacific is back at work, which is their next day. 9 p.m. our time which is I think 7 a.m. our time, we reconvened. And there was a back and forth dialogue.
D: And, was that an extension of your normal interaction? It sounds like an additional routine you had to setup.

L: Yeah, it almost what we did the first time when we declared the scope, but we had to do it again on top of actually managing this release I was trying to get to the next phase… on top of managing the five other projects.

D: Do you think there was any other way… Well, when did this occur during the project?

L: This was in the design phase.

D: The design phase, so it was, say, in the… if the timeline has five pieces, this is step two?

L: Yep, you have your plan, design, test execution, and then your deploy.

D: And, was there some specific, you say the phone was difficult for the Japanese members, did you try any other technology or any other route to get to them? And email was even worse it sounds like.

L: Yeah, email does not work well. We have a chat system we use internally. That works well too at times, but because of the time differences, you’re not going to catch them online and they’re not going to catch you. So, the only medium to use where you can really try to drive understanding and get it to a little better comprehension would be to do it over the phone. Of course that means a severe inconvenience. Either I had to call late at night or meet early in the morning or vice versa. That’s about the only choice you have.

D: Now prior to this you weren’t running these, as you say, severely inconvenient calls, right?

L: We’d do them but sparingly. They were more for status. They weren’t to negotiate things any longer. But, when we were first going through the plan phase and we were deciding
what’s in scope and what’s going to be committed and things like that, there were calls setup to review, the scope, the design, those types of things.

D: Is there a central repository that keeps track of the scope?

L: Yes, there is.

D: And could they have checked that to see what was changing?

L: Yes

D: And does it keep track of the reasons why changes were made?

L: To an extent, yes.

D: Ok, would you consider… when you made the change and you made these meetings happen, morning and night, would you consider that effective or ineffective?

L: Relative to what?

D: Did it work?

L: Yes, see there’s ineffective, it would be more if I could have gotten the AP folks over here. We could have hammered things out and worked it out in one day as opposed to taking a full week.

D: Do you think there was any other way to do it virtually? Was there perhaps some other information or communication technology? Or, could you have expanded the project scope repository in some way that would have brought the Japanese in during the original process?

L: yeah, I’m almost certain there are better ways to do it. My problem is, because the way the economy is these days, everybody is stretched to their limits. They don’t have time to put the thought process behind what you want to execute and how you want to execute it. You do things in haste more times than you want to. So, I am 100% certain that there is a better way to do this, but if I had the time, what I would have liked to have done, through the meeting, the
eMeeting we actually use I could actually ask a question and have everybody say yes or no, see if they actually understand and agree. But, we have only two hours to go through forty pieces of scope. It would have taken me fifteen minutes per piece of scope just to get everybody to click the answer. It’s a bad excuse. It really is, but just because of time constraints we did the best that we could. So you ask yourself, well, those extra fifteen minutes per piece of scope would have saved you the week of work. But you don’t see that until Monday morning quarterback.

D: You’re getting at the nature of my study, But, there may be some way to make those feedback polls be more automatic, or less cumbersome.

L: True, it could be a limitation of the technology, but ultimately our problem lies in the differences in cultures, and the language barrier is always around us on this project,

D: Sure, I lived in Japan for three years so you’re getting at something I’ve run into myself, Ok, so let’s move on, because we’ve got to cover four of these hopefully. So, what evidence specifically did you have in terms of the change in technology use. That’s the question.

I know that they used the telephone, so that’s clear. Was there any other change?

L: Change to a technology?

D: In the use of the technology. So, the communication technology, you started to use it more intensely, morning and night. Do you know if they were using, say, the shared scope repository more frequently or were they were using chat less or email less?

L: No, we didn’t add any technologies, but we emphasized them certainly a lot more when I came on board. Are you considering software technology as well? Like Microsoft Project?

D: Sure

[skip to C2]
And that AP issue, if you wanted to define it in one word, it was a collaboration problem. They felt like we weren’t collaborating with them, and when they were trying to derail the release, I felt like they weren’t going to collaborate with me. So, by using things like chat when it was possible to do so, though there’s only a couple of hours a day when you’re actually able to do so, when you’re both actually awake, but using chat, using the teleconferences, and sharing as many documents as possible, whether through the virtual sharing space or wherever it could be, to drive the point across by collaboration and provide status back and forth, because if I said I’ll consider it and I’ll get back to you, I’d still go back to the same problems in collaboration, but by constantly meeting with them, after hours and before hours, they saw my dedication to the issue. I saw their dedication to the issue, and that made a big difference.

D: Ok

L: Because, on email, when you send an email, Americans tend to send a note, “Hey Dominic, send me this document,”

D: yes, sure

L: And in Japan, it’s like. “Dominic, I hope all is well with you. Thank you for taking the time to read my email.”

D: Right

L: So, it’s a thoroughly different approach. So to avoid all those pitfalls using technology like teleconferences or chat, using them the right way to try to communicate in the way that they understand. You know my online goal is to get the release out the door. And if that meant making people happy along the way, and if the best way to do that was to use teleconferences and chat, but really email only seems to add fuel to the fire.
D: Ok, let’s look at the trigger. It sounds like we’ve actually got two incidents here. One is the conversion from release one to two. You came on board to get project back together. You put in MS Project, some of the organizational tools. The second one is this breakdown in communication with the Japanese. I don’t know if you can hear that. It sounds like to me that you’re actually giving me two incidents simultaneously,

D: [skip back to C2]

D: Talking about that week. At what point did you get triggered? When did you say wait a minute, I’ve got to do something about this.

L: When I was blind-sided with a note that I was copied on that went to my executive VP. Their reaction in AP, and I don’t know if this is typical, but their reaction is to immediately escalate to the highest level. And, my VP is 3 above me. I’m a junior director. I have a director, and then I have an executive director.

D: Ok

L: And in our company, a director is most likely the equivalent of CEOs in most other small and medium businesses. So when you go to an executive VP, the CEO is only three or four doors down from this guy.

D: Ok

L: So, when I got the note it was stop the press. Stop everything that we’re doing and be 100% fully committed to what’s going on here. Our problem was, the project that I’m on is the other areas of the project had neglected AP for so long that they feel like the ugly stepchild. So, our executive VP has taken the tone that we must do more to embrace them and drag them to adoption of the tool.

D: Is that the project we’re discussing or a different one?
L: This one. And all the projects that are associated with the overall division. So, this division that I’m in is doing up to 15–16, 20-30 projects at one time, all in support of one central tool. My project was one of the projects at the core of the central tool, but of all the 30 projects, they’ve always had problems in the past of roping in the AP folks. Because it’s hard.

D: right

L: You know the language barriers, the time zone issues. All those things can put up obstacles. Since they felt that way for so long and this has been going on for probably 3 or 4 years, they now have an inroad to an executive VP who has declared further integration and adoption in AP. He kind of gave them the path to escalate to them. So, once that happens, once they escalate to my executive VP, that was more than a trigger, that was an explosive.

D: Yeah, I could see how that could be explosive. How did you deal with that? What personal skills or abilities of you personally let you deal with both things, first coming into the project, second this issue with the Japanese?

L: Personally?

D: Yeah

L: I think it’s a couple different things. One of them is definitely having empathy. I understand why they would feel they way they do. I’ve known for a fact that they have felt this way for a number of years. So, I understand that. The other thing would have to be that being a project manager going on 8-9 years now, there’s always a solution. It doesn’t matter how far along you are on a path towards cutover, you know, going live with your product. There’s always a way when something comes up that you can address it and work through it. Taking the path of least resistance, just saying, well, put it under the rug. Of course, I did have the VP thing, escalation on my back, I couldn’t exactly shake it off if I had wanted to, but if I did take the path
of least resistance and just ignore it, it would just rear its ugly head down the line. And, make it worse. So, its better to deal with it when it surfaces. It will be easier and I’ll have enough time in front of me. So, realizing as a project manager that there was a way to resolve it, that it wasn’t the end of the world. That probably made it easier to resolve the issue. And the fact that I genuinely care about doing a good job. Even though there’s a team, they also have a say in whether or not they think I am good at what I do. And, if enough of them start saying this guy doesn’t run projects well, I’ll be out of a job.

D: Sure

L: So, it’s kind of awkward, as a project manager, half the time, they’re your team members and they’re also your customers.

[in response to what he would do differently in retrospect]

But when it comes to AP yes. Now, my current practice with AP is, it takes an awful lot of extra time on my part, but as you can tell, it’s worth it. After a call when we’ve discussed important things, to hold a follow-up call with just the AP team to make sure that they understood what was said.

D: Have you tried doing that any other way than a call?

L: No

D: Ok.

L: There were sometimes some emails, when they summarize what they think was the substance of the call, which was they’re understanding. And, it’s almost always wrong. I started typing a couple of notes back to them which were saying this where you went off track, but these notes were getting to be pages long. To make it worse, to make sense, if I got it wrong, then it would be in writing. And if they misinterpreted it, I would still be in the same problem, but the
speaking part of it, I think, makes a big difference. You know, I think I’d prefer, if I was in a perfect world, to do it face to face, because even the body language drives understanding.

D: What about, say, a video conference?

L: Our company does not support them.

D: Oh, you don’t?! You have the technology.

L: Oh, absolutely. We have a lot of infrastructure, but coincidentally, I just signed an affirmation, or confirmation, whatever these things are called, just yesterday, we do it yearly, which says things that you should and should not be doing with your PC as an employee of our company, so you know, don’t download porn, don’t try and update them, and one of the things was don’t try to use a video conferencing device unless explicitly given permission by your manager to do so.

D: Huh, that surprises me.

L: It surprises me too, because I think it would help. Well, maybe, I haven’t really looked at them before with the exception of in an academic program.

D: Right

L: I really haven’t used it for work. So, I don’t know if it would make things better or worse. The problem is because of our schedule. Our people would be in their pajamas on these conference calls at 5:30 and 6:30 a.m.

D: So in some ways it’s better not to have the video I guess.

L: Yeah. But for the AP folks, I wonder if it would help, because they would see sincerity. Or, you would hope that they would see sincerity.

D: So, they need to see sincerity.

L: I think the AP culture does. I think they’re different than Americans that way. I think Americans are very blunt. Sometimes I think we don’t even like seeing each other, and I think in AP they
need to feel endeared, and they need to feel like you’re a person. Otherwise they’re going to treat you like you’re not.

D: Yeah, I’ve heard some people do that. That’s why I ask. What was critical about setting up that follow-up call, that special call with the AP folks?

L: It just helped avoid misunderstandings, to address them by just having a 45 second chat with them. We’ve found now from doing these consistently that the chats started off as a couple of hours long, which was, well, it would become midnight real fast. To now, where they are sometimes 25 or 20 minutes long, where they say we got everything, we understand it, no issues, or we have one issue, here it is.

D: That’s interesting.

L: They’ve become much more amenable to what we’re trying to do since we’ve reached out to them in this teleconference. And, I think that this team, the QDB team that I’m managing now is probably one of the only teams that does this, but it’s one of the only teams that delivers on time and on budget.

D: Let me write that down as well. So, back to your performance measures, essentially, you’re on time and on budget.

L: Oh, yeah.

D: ok, that covers two incidents. Do you have another project or do you have any another comments?

L: One thing here. I’m getting a note that I need to be on a call at 2:30. So, if we don’t make it, I’d be more than happy to reschedule.
D: ok, we’re doing pretty well here, so we may make it. You said you had another one. So, let’s move on to that one.

**Critical Incident 2: MS Project (7:39 – originally intermixed with C1.)**

[skip in from C1]

L: Those were things that we used in the past, but when I came on board they were used in a style I’ve never seen. There was no interlock between project plans. There was no review of project plans. They just currently existed for the fact of existing. Nobody was working from them. And they’re not by all means the only thing that guides the project, but they’re certainly one of those things that help point out problems right away and make people aware of upcoming activities. So, emphasizing additional conference calls. There weren’t standing meetings on release 1.0. They just happened when people thought they should occur, which means people didn’t have the focus. For release 2.0 we definitely used teleconferences a lot more for everything from problem resolution like the AP issue we had to standing calls. They just did not have standing calls. Things just kind of happened in a vacuum, and not using interlocked project plans also meant that people did not feel like they were part of a team.

D: Right, right. Ok, what about in terms of the project’s goals. How did the change in technology use result in a different outcome? And here I’m looking at that week. That week in which you went through the intervention with the Japanese group and had those extra meetings.

L: The extra use of the technology or the emphasis on it, I think made an outstanding difference.

D: Ok, how so?

L: Excuse me. I have a little bit of a cold…

D: No problem.
L: What happened before is things weren’t emphasized and they weren’t very core. And by starting to push the uses of technology, such as phone or even chat, it enforced constant communication and collaboration.

[skip back to C1]

L: One thing I was saying is that Microsoft Project may not be an incident because it’s something that I drove from the get go.

D: Right, but you were brought into the project because it was having trouble it sounds.

L: Sure.

D: And that was one of the ways that you were able to make into what became very successful.

L: True

D: So, that’s what I’m hearing, just to give you a reflection of what I’m hearing.

L: Sure.

[skip to C1]

D: I’m just looking back, because it occurred to me when I mentioned to you that you were giving me two incidents. Let me make sure that we cover the first one well enough. When you came into the project, how is it that you realized that they weren’t using Microsoft Project well? I know that… what came up? You just saw it there sitting in a shared repository?

L: Well, I didn’t know what QDB was and what my charter was. I had no idea what this tool did. I had no idea what these requirements were, and so I asked for all the intellectual capital from the previous release. So, they said, well, here it is. So I went to the repository and I opened up all the MS Project plans, and they all had constrain dates in them that had been built by my predecessors. There was no interlock between the plans. That’s the way the plans were
constructed. The use of them more like an Excel spreadsheet than a Microsoft Project plan. So, I knew right off the bat that I had a problem. I had project managers who weren’t really project managers. They were task managers. And they had no business building project plans.

D: Tell me a little more about that. What’s your distinction there between the two. What’s a task manager and what’s a project manager?

L: A task manager just cares about specific tasks in a project plan and bringing them to completion. A project manager cares about keeping all those tasks together, keep them whole. There’s a relationship between just about everything in a project plan. I mean everything is an input to something at some point. There are very few exceptions. And, a project manager is really responsible for keeping the whole ball of wax together, that giant thing of tasks and all the interdependencies that spider web that forms between all these tasks. That’s what project managers do.

D: ok

L: These were task managers. And they called themselves project managers, and the problem with doing that is that they were given projects to manage.

D: Right

L: As opposed to individual tasks. So, in some instances I actually removed project managers and said, you know what, it would be easier for me and less risky for me to take on the work, or give it to my assistant to do it than it is for you to do it. So, you manage this piece, and don’t worry about MS Project. I’ll tell you what to do and when you need to do it. I’ll put it in my plan. It’ll keep everything more consistent.

D: Ok, so you did that pretty early in the first phase?

L: Yeah, I was brought in to fix this team.
D: Ok, and were there any other tools you noticed that weren’t being used well or weren’t being used. Earlier you mentioned emphasizing tool use. Did you setup any rules?

L: Yes

D: Norms, or something like that?

L: Yes, project control books. They didn’t have project control books. That tells me what the milestone tasks are, which are just directly exported from MS Project. It’s not like keeping two sets of dates and two separate books. But, some sort of project control book that shows your dependencies, your risks and anything else you need to put into it. They weren’t tracking any of those things, and risks popped up all the time. And there was no mitigation strategy to deal with them. So, the project control book is what you put in place to deal with it. Now, I knew that I was coming into an uphill battle coming into the team. So, right off the bat I kind of came in with an eye for what to change.

D: Sure, what’s the… give me a general idea of magnitude of this project in terms of the budget.

L: Yeah, the budget’s around 2.3. Each release is about 2.3 million.

D: Ok. So, it’s a serious investment.

L: Yes

D: Looking back, is there anything you would have done differently in either situation? When you came into the project or that specific incident with the Japanese.

L: Coming into the project, no, I wouldn’t have done it differently. I’m sure there’s a couple of things here or there, but generally speaking, no, that’s the way I do it. My hiring director brought me in specifically to do what I did. Don’t worry about hiring people, don’t
worry about firing people, you do what you need to do to change it, just get these things off the
ground and stop this constant churn of releases.

D: Right

L: So, from that part no.

[skip to C1]

D: Right. This is a critical incident. So, let me ask you, and I’m splitting them here,
because I think you really have two. So, what was critical about getting Microsoft Project and
the management side setup when you came on?

L: The five Ps.

D: Yeah, why was that critical?

L: It’s the 5 Ps.

D: What’s the 5 Ps?

L: Proper preparation prevents poor performance.

D: Ok

L: What about that? Because, everybody’s virtual.

D: Right.

L: It’s like herding cats. There’s no common ground for people to stand on. Where we
are today. Where we need to be next week. Who’s responsible for what. There’s no way to
easily declare all that other than Microsoft Project. That I’ve found. It’s a common mechanism.
So, it’s easier to disseminate who’s doing what, where’s it being done, what’s required by who
and when. All those things are best declared on some type of medium and that, for me, has
always been Microsoft Project.

D: When you say medium, do you mean, say, written?
L: Yeah, because I can put Microsoft projects in team rooms. I can put them in e-meetings. I can put them in email.

D: But, you don’t mean, say, if you were to verbally record it and put it out there.

L: No, no. No, no.

D: And, do you do that? Do you ever catalog the conference calls and put them into a shared repository?

L: No, but that would be a very good idea, now that you mention it. Especially for the ones when we review things that critical like scope.

[skip to C1]

Project Context Two: CRM (38:11)

L: Yeah, this is the bigger one. This is the one I did before QDB.

D: Ok, let’s go through the project form. So, I’ll get out a new form. If you want, just read me the answers. I’ll write them down, and I’ll ask a question if there is anything I misunderstand.

L; ok

D: So, project reference name?

L; CRM

D: And is it a CRM application?

L: Yes

D: Longevity?

L: 14 months

D: History?

L: On-going, many times, only team leader, top-tier on this one.
D: But not the ultimate?
L: no, this was a $55 million dollar budget.
D: Ok
L: And I was one of multiple designated leaders.
D: People?
L: 78. And that number just comes from the project plan.
D: ok
L: There could be more. Grouped in teams? Same thing. Developers, testers, business unit reps. Again, representing 8 organizations, well actually 9, with two firms.
D: So, it wasn’t internal entirely.
L: No, we had an outside firm that was developing a database that was going to integrate with our tool, which will become our incident when I get to it.
D: ok, I think I have a sense of the organization. Was it the same as the other?
L: Yeah, same exact values.
D: What about the breakdown of countries and time zones?
L: I’d say they’re just about the same as the other one. 50, 10, 5…
D: and then the remainder down in constantly traveling.
L: Right
D: Native language?
L: 70, 65, something like that.
D: And varying experience?
L: Same thing. It was like a bell curve.
D: Ok, anyone leave or enter?
L: Yes. It was regular turnover, but the thing is the developers on this project are contractors, unlike the you know the QDB project which was in-house, with contractors their contract runs out and they replace them with someone who they claim is exactly the same, and that becomes a risk.

D: ok, were people splitting their time?
L: yes
D: Same as the other one?
L: yes, cross matrix.
D: What about the technologies? Same thing?
L: Same thing. Do you need to go back through them?
D: no, I’ll just take a note. Task nature…
L: This one was to bring a new business online with a CRM tool.
D: Is it a new tool, or were you just customizing it?
L: you got it, customizing it. Or, enabling functions and customizing.
D: So, in a sense, you were extending it.
L: you got it.
D: So, some of the options didn’t exist in the software. You had to make them.
L; Right.
D: ok, was there a formal orientation?
L: no, well, I take that back, yes. This was to bring marketing onto the tool. So, for the marketing community there was an orientation that was done for them.
D: but not the whole team?
L: No, because the rest of the team, what their responsibility would be in this release was to continue to make sure their function did not break as a result of the new function, but the marketing team was going to doing was what the other groups had done in previous releases, which was on-boarding their entire community from whatever tools they were on to this new one. So, for them there was extensive orientation. There were fit gaps. There were jobs. Those types of things.

D: And, for the other people, were there introductions to the other people or anything of that nature?

L: For marketing yes.

D: Oh, so the marketing people were introduced to the current team?

L: Oh, I’m sorry, no I thought you meant the tool. No, there was no formal, you just had to learn people’s voices and figure out. Oh that’s Tim and that the project manager… he’s this guy.

D: What about … was that orientation face to face?

L: no, well, which one?

D: the one with marketing?

L: Yes.

D: They knew each other from face to face, but they didn’t necessarily know the rest of the team.

L: Right. Because, what would happen, every release, regardless of whether you had function being enabled, or part of scope, you’re always having to do regression. There’s no need to bring the entire team, not even the developers, on board. What you have is just you bring your business analysts, and bring them together with the marketing reps and develop the requirements.
D: ok, was there a formal wrap-up?
L: Yes
D: What was covered, briefly?
L: On this project, because it was so large, there was a lessons learned review. And there’s also the go-no-go decision. And then we also harvest all the intellectual capital. So, any new products that we develop. Any work products that we develop. Intellectual capital that we can harvest and put out to the company’s intellectual capital database, that’s all done at the tail end.

D: So, the company’s intellectual capital database is like a knowledge management system. Ok, who initiated the project?
L: That would be an executive.
D: And, why?
L: Because of all the applications we have in the company, we have thousands of them. The idea of having so many different applications with customer information as a thing of the past, so this was all part of the hype around CRM, collaboration, and sharing of a single repository of all the customers.

D: Were there any whole team face-to-face meetings?
L: Whole team? No, but there were sub-sections of teams that would meet.
D: Face-to-face.
L: Right, but it was rare.
D: How rare?
L: Once a month at the most.
D: Ok, but never the whole team?
L: No

D: Did the whole team ever meet synchronously? Conference call, anything like that?

L: no, because the team was so large. 78. It’s actually more than that. If you count the total number of developers and customers, the numbers more like 300.

D: Wow.

L: But, the leads, that’s who we dealt with mostly. The leads is only 78. What we would do is depending on what we were doing in the project, different leads dropped off or came on board. We would meet with the leads, and the leads are responsible for bringing their information into the project plan.

D: And leads are, say, the lower-tier project leaders.

L: Right.

D: … who supervise, say, 3 programmers or something like that.

L: More than that. They would be people who would be in charge of all of the developers for a particular phase. So, that lead got 60 people, and then the tester lead got 45 people, and then the architecture guy who has 10 people.

D: Ok. What technologies were you using to meet virtually?

L: Same as the previous ones. We had e-meetings setup. We had teleconferences.

D: ok

L: For problem discovery and resolution, chat was used quite a bit. When defects were coming up during test cycles, it’s faster to get people up on chat and bring them into a chat room than it was to get everybody onto a quick conference call. Typically, people were already on one.

D: ok
L: Which means you can’t focus on any one thing.

D: Ok, What were your metrics of project success and status?

L: Same thing. We used critical path.

D: And how would you characterize the status at the end?

L: It definitely was not a nine. Ah, 7.

D: So, it was successful, but it was not very successful?

L: No, that was because of the critical incident.

D: ok, any other notable outcomes?

L: Actually, yes, because for other work products we developed, this was my first CRM release. There had been 8 previous ones before that. The assigned number didn’t really mean anything because sometimes they cancel a release and merge it into the next one. So, other project managers had led them. Some of them were good, and some could be reused. A lot of the other ones were not. So, a lot of their end-to-end processes, I didn’t think, they needed to be updated. They didn’t reflect how the project needed to be managed now. You know, it started 4 or 5 years before I started. So, different types of processes were used back then. So, we got to update the process and update a lot of work products and to this day they’re still using those work products and processes for the project. So as part of the harvesting of the intellectual capital at the end, that was a noodle.

D: Was there the same methodology as the other project?

L: yes

D: Was it mandated?

L: yes

D: And how strict were you?
L: Very, very strict, because this project was done through a much different type of accounting structure. This one was based on ROI, cost of capital, all those types of measurements were put up against it. So, $55 million had to meet, kind of a… what do you call it, a performance threshold, a return threshold. So, what they did, they actually had a company-internal review where I would have to go up in front of a board at different phase starts and ends and declare that I had completed these things, they were done in accordance with the company, and that we were ready to proceed with our next cycle, and everything was good. If not, then they would have said, well, the funding was cancelled. If you can’t keep yourself yellow or green, then we’re canceling.

D: So, were you the release manager?

L: Release Manager, RM.

**Critical Incident 3: CRM (50:06)**

D: All right, let’s go to the incident here.

L: So, there was an external company. It was out of a Midwestern state. They’re an up-and-coming company that does development work and create external databases for use in marketing. They had their own project managers, but we, in our company, determined that we should put our project managers in charge of their project managers. However, our project managers were good technical folks, but they weren’t, to put it frankly, they weren’t hard-asses. Since the beginning of the project we knew that the development of their product and the integration with ours was critical path, we couldn’t get into any kind of test cycle until they were done with their development. They slipped consistently. We tracked only minor tasks in their project plan, but every single one of them was always red. And red I mean, it’s slipping and we don’t know how to recover. We tried everything we could, I think, to get them to bring status, but we didn’t get there. So, the release ended up being delayed. It was supposed to be a year,
and it ended up taking, I think it was an additional 2…. 2 and half months. Which was a very bad thing. Because you’re tying up 300 resources from moving on to the next project, which becomes a snowball problem.

D: sure, and what … were there specific… you mentioned the managers. You had some who were technically very good. They were domain experts it sounds but not necessarily good project managers. And then their people were not self-managing in such a way that it gave you the status. What were the aspects of that in terms of the technologies they were using? What should they have been doing to report their status?

L: Well, they would report their status to us through presentations. They would report their status and also their actions against them. They would also provide us with their project plan to show us where they were with their tasks.

D: you mean they would email you a Microsoft Project file?

L: They would post it to the repository. I would grab it, and then we would have standing calls where we would review.

D: In the standing call they would give the presentation?

L: right

D: How? How did they do that?

L: We’d all be on the call. The presentation or information was available for us to retrieve it. We’d open it up and they’d take through it.

D: So, verbally. But you didn’t application share so they could control what you saw on your screen?

L: We tried e-meetings, but we saw that it took a lot of time to get people onto the e-meetings. It was faster to post it up to a repository and say go get it. With an e-meeting the page
has to refresh, people have to get the e-meeting running and the password, and there’s always a problem. So, it became a headache. We found it to be almost as effective to just have people with the presentation in front of them and they could just flip through the charts.

D: ok. What happened? So things were going bad, getting worse. What did you do?

L: I high-jacked the project.

D: High-jacked it!

L: Oh, yeah. We tried several times to make sure the managers understood, the project managers understood, that this part had to be delivered on time. There was no slipping of the date. And the problem was, they had a hard time, they had a hard time driving the external developer. They also had a hard time integrating them with the lines of businesses. So, the developer for this product couldn’t work in isolation. Their plan and their design for this product came from the marketing group. Marketing told them how to design this database and what to do, but I don’t think that those managers put the time, effort, and energy into making sure that every step possible that everything was the way its supposed to be. And, not so much that they’re lazy. I think that they’re just more accustomed to taking things for granted. And, I guess I’m just a little bit more suspicious, especially when it comes to an external. And when I know that I’m managing a critical path item, I’m going to stay on top of it. Time and again they did not. And, when we finally got to the point when we took it over, well I took it over, and went into what was actually occurring, it was an absolute mess. An absolute mess. They had missed all kinds of requirements. Ones that they had were not being developed correctly. Their tests had so many defects in them it was unbelievable. So we had to stop the release.

D: How did you highjack the project? What did you have to do to make that happen?

L: Went with the project managers to the external’s headquarters.
D: So, you actually setup one of these face-to-face meetings.

L: Yep, which is something I never want to get involved in. All I want is a project manager to tell me here we are on this task and on this task, here’s what I need. Here’s what I don’t need. That’s all I want to know. I do not want to get my fingernails dirty. I wasn’t supposed to. This is a person with a management level, so they should be able to manage on their own. But they were not. So, instead of them going to the site on their own, I told them I will be going there and I will be doing the talking, you just sit there.

D: How did … what did you have to tell them then? Did you change the way that they would be interacting after that meeting?

L: Yes, the team, the external team was no longer going to be represented through the project managers and they were going to report directly into me. And they were going to be on daily standing calls, and I wanted visibility into exactly what they were doing. The good news there was that because they were an external contractor, we were paying their paycheck differently than paying an internal resource. So, I had the ability to speak with the VPs to make sure that they knew that they were at risk of being canceled. And that made sure that they got involved as well. So, that increased visibility. Then, as far as being told that they only had 3 or 4 defects, they actually had more like 70. I can’t remember the number, but I think that it was 65 or 70, something ridiculous. I was actually able to track all 70, and I wanted status on all 70. If that meant a 2-hour call, it meant a 2-hour call. It’s an extreme situation, but the problem was, you know, we were 2-months slipped and at risk of losing our funding.

D: Yeah, and with a huge project. So, did it work effectively?

L: Yes, but my regret is that I did not get involved more, earlier. I should not have let it got to the point where it was in the red.
D: ok, so was that what triggered you? The first time you saw red you said, whoops, I got to do something here.

L: No, I let them fix it. And they gave me good reasons. They seemed like good reasons as to why. And I took it for face value. You’re a project manager, you’re a professional, I take things as you present them. But it wasn’t the case.

D: so, after a few times, you decided to get involved.

L: It was a bunch of posturing. And I was tired of it. I wanted resolution. What they were developing was not rocket science. There was no reason for it to be so broken for so long. But the problem was I was trying to do the right thing, which was give the person a chance to manage their own project. So, don’t do that, don’t take it from them. That has ramifications, but I was interested more in getting the project out the door at that point, when I took over, I was more interested in getting the project out the door than I was about making friends.

D: How did this effect the ultimate result of the project? How did this intervention, going to the external site and setting up these daily calls, how did that lead to a different project outcome?

L: Because we met status and actually knew status, and it actually got us to go live.

D: Do you think the project would have completed the way it was going?

L: No

D: It would have failed.

L: Yes

D: So this is the difference between completing and scrapping.

L: You got it. Because, it would have gotten to the point where it would have spun out of control and people would have said forget it.
D: ok, you were in the external site for a week. At what point in the project was this incident?

L: We were already in the test phase.

D: Test, ok, so you were say 4 out of 5.

L: Ok, say next to last. The deployment phase is very short, say, 2-4 weeks, but we were in the test phase, and they were still in the development. If you ask me, they were still in the design phase of this application.

D: You said in terms of doing things differently, you said you would have gone and intervened earlier. Is there anything else you would have done differently?

L: This going back now about 2 and a half years. Let me think here. The problem with the way my company had me setup at the time… I was going from one project to the next immediately, so there was no time for reflection. Getting involved earlier. But I think also, I should have driven more of how they report their status and what their problems were. You see the problem is you walk a fine line, right, because you can’t really dictate to somebody how you want to see things and, you know, I don’t want to ridicule, there’s a sensitive way to do this. And if you don’t do it properly, it sends a bad message for everybody else. That’s why I was really hesitant to highjack the project from them in the beginning, because it would send a bad message. That would start jeopardizing cooperation with everybody else.

D: Could they actually login to your repository and put their status directly into Microsoft Project?

L: No, not at all. We had talked about doing things like that, using Microsoft server. But we just never got to it. But, you know, letting other people touch my project plan always ends up being a bad idea.
D: Right, unless you have access control.

L: Right, because I always had a note of a foul up with the first line that was saying “I don’t know what I did, but…”

D: Oh, man. Yeah, that sounds bad. That’s not what I would want to hear either. What made this critical? Why was it so critical that you got everyone to the external site face-to-face?

L: There was no other way to resolve the issue. And without resolving the issue, we would be a no go and probably lose our funding.

D: Wht face-to-face? Why physical presence?

L: Because over the phone was not proving to be any more effective.

D: What do you think it made happen? I’m trying to figure out what exactly changed.

L: I think people. You know you do things over the phone and people take a certain amount of seriousness with that, but you tell someone I’m going to be there Monday morning first thing. And, all or a sudden the seriousness escalates and people’s focus sharpens. When I see you face to face you got them and they’ve got you. When I hang up from the phone after 50 minutes, and I hang up. I might or I might not do what you said, but having somebody physically there, it changes their demeanor. It changes their focus.

D: So, it’s harder for them to just be flippant or posture as you were saying.

L; Yeah. When they give me information I can see the information that they’re giving me. They can’t invert it in some pretty-looking PowerPoint.

D: Right. Ok, let’s go. I know you’ve got 10 minutes here. Is that right?

L: yeah, 2:20.

D: Ok, let me see if I can get through the General Model questions. We may be able to do these in 10 minutes.
General Model Questions (1:03:19)

D: On the importance and frequency of technology facilitation, which is what you are doing when you change the way people are using the phone in the group or changing the way people are using Microsoft Project to report status, that kind of thing, you’ve got a lot of different duties beyond that. On a scale of one to ten where one represents total non-importance and ten represents absolute, critical necessity, rate important it is for you to facilitate technology in the teams you lead?

L: 9

D: Briefly, why?

L: If I’m responsible for the project then things need to be done, not 100% my way, but they need to be done in a way that I can understand. And it needs to be a way that other people can understand as well. So, the question that you’re asking is not necessarily the use of technology, right? Because that’s a no-brainer. Otherwise, no technology, no project.

D: Right.

L: But, the change of the attitudes and the uses of them. Because, if I don’t get everybody, like I said, it’s like herding cats, if I don’t get everybody going in the same direction and emphasizing things the same way then nothing happens.

D: Ok, Let’s do a similar question. On a scale from one to ten where one represents never and ten represents constantly, how often does the need come up in a project once the work begins?

L: 10

D: So constantly.

L: Yes, every project requires a change… a change to the use of technology.
D: Do you think that there’s almost always one in the middle of the project, or can you handle them all in a big orientation?

L: One in the middle of the project?

D: Well, for example, the Japanese issue came up in the middle of the project.

L: I see what you’re saying.

D: Do you think it would ever be that you could just have one big orientation and everything would flow?

L: no, the only constant is change right?

D: Ok, well you know if you read a lot of the literature out there they say that if you do it all up front and it just flows. But I have not seen that.

L: You know, project management is not about execution to a process. It’s about when a process derails, how do you get it back onto the rails. It always requires a shift. And a project manager needs to be able to react to it. My style of project management may really turn people off. If I really want to get the project out the door, then I’ll adjust, even if the PMBOK tells me that that’s exactly how you manage a project. According to the PMI institute that exactly what you’re supposed to do…

D: Yeah, I know.

L: If you took that exactly, that would be probably the worst project manager I have ever seen.

D: Do you have PMI certification?

L: Yeah, I’m PMP.

D: Let me move on. I know we’re running low on time. We just went through those two projects and you told me which information and communication technologies were available and
the ones you actually used. Every team needs a set of those options. I call that their technology toolkit. Go back, if you would, to the project description guide and tell me which ones, from your experience, what technologies you would include in that toolkit. If you could just screen down to the ones which were most critical and tell me which ones those are and tell me which ones were important and which were critical and why.

L: Ok, under question 6, The most critical.

D: yes, right. Well, which ones were just important and which ones were critical.

L: Audio conferencing 1, Calender is a 1, Chat is a 2, Desktop is a 3, development is 2, document versioning, we don’t have it, email is 1, fax is 4,

D: That’s fine because you can say a 0 is not important at all.

L: FTP/File servers, eh, skip that one. It’s important. It’s just not the way we do things. Group decision support system 2, groupspace 1, instant messaging is a lot like chat IRC but 2, mail 3, org portal 3– should be 1 but 3 unfortunately– project management tool is 1, telephone 1, discussion board 2, video conferencing 3, virtual meeting tool 2, web pages 3.

D: Ok, why would you put the telephone so low. It sounds like you use it so frequently?

L: No, I said one.

D: Oh, one is most important. Ok, that’s fine.

L: Sorry

D: No problem. I just need to make that clear. So one is most important and four is not important at all. Are there any that need to be invented in terms of these technologies?

L: You brought up a good point that I should use recorded teleconferences, but it’s invented, I just don’t use it. I really should.

D: Well, we talked about it some earlier.
L: Well, some of the things I’m seeing coming up in the market like a specific project management office suite, which is something my company bought but we’re not going to use it. It’s something that integrate a lot of these things that are disparate right now into one place. So, you have your team space. You have your organizational repository. You have your development support tools. All the stuff is in one place. I think that that’s the right direction to go. However, when I try, I’ve been trying the tool and there’s so much there that you have to know so much to use any of it.

D: Sure

L: And that becomes a problem with it. So it would be nice if we could connect all the different things together. My Microsoft Project tool is completely different from my repository where I keep my scope. But again, they’re good, but you really need to be like a PMP to understand how to use them.

D: Sure

L: And my problem with that is, maybe I can use it, but half my team, the other 78 people won’t. They don’t know how to use it, and it might cause more problems than it solves. But then again, as people learn…

D: Let me ask you. We’ve got three more questions and it looks like you’ve got three more minutes from my clock here. Is that a hard deadline?

L: Ah, I’ve got to lead the call. That’s the only problem.

D: Ok, let’s go real quick here. I’ll skip the mental model question, because I think you’ve touched on that earlier. Is there any specific knowledge that a virtual team leader needs to have in order to be a successful technology facilitator?
L: Specific knowledge? I think that when it comes to technology it’s more about aptitude than it is about specific knowledge. Because, every time as a project manager when you take over a project, even if it’s the same technology. Even if it’s that same tool, it’ll be different.

D: OK, so, the ability to figure out and understand the tool, even if you know the tool already.

L: Um, hmm

D: What if you don’t know the tool already?

L: Definitely, you want to ground yourself as much as you can by taking a course or reading. Of course, more times than not you just don’t have that time. So then surrounding yourself, making sure that your staff that you’re reliant… as a project manager you’re really not supposed to care too much about how exactly something is developed. You just want to make sure that it is done correctly at your level. So, if you have the right people in place who do understand the technology and you can rely on them, you’ll be successful. So, you just have to surround yourself with those other people. So, you need, as a project manager to know that you have the right set of people.

D: Let me ask you two 1 to 10 scales and we’ll be done. And thanks for talking today.

L: No prob at all.

D: It’s an excellent interview with some good incidents. How would you own knowledge of the technical usefulness of different technologies on a scale from 1 to 10 where 1 is total weakness and 10 is complete understanding?

L: 7
D: And how would you rate your own knowledge of the ease of using, how easy it is for other people to use the different technologies from, same scale, 1 is very weak and 10 is very capable?

L: I’d say 8.

D: Ok, well, that’s it. We’ve wrapped up the interview. I see we’re right on the minute here.

L: you got it.

D: I’m going to transcribe these. I’ll send it to you in an encrypted PDF to review. Hopefully in the next week.

L: Ok, great. Thanks.

D: Ok. Good talking to you.
APPENDIX V: ANALYSIS DATABASE SCHEMA

Relationships for CodeLinkAnalysisDBv1 (Dominic Thomas's Copy)
Friday, May 13, 2005
APPENDIX W: SAMPLE GRAPHICAL SUMMARY OF TWO CRITICAL INCIDENTS
EXECUTIVE SUMMARY

In dispersed or virtual teams, there are usually 12 or more information and communication technologies (ICTs) in use and understandings of them among the team members vary, leading to frustration, breakdowns in team interaction, and additional pressure on top of variable team membership, compressed timelines, and tight budgets. Effective virtual team leaders recognize this situation and use ICTs as a lever to improve team interaction and achieve better project outcomes.

To use ICTs as a lever, successful leaders do the following:

1) Do initial testing and training on the ICTs the team will use. Use this initial training as an opportunity to develop a joint understanding among the team members of how ICTs will be used, especially in teams with members from multiple organizations. Set an initial communication policy that covers ICTs, even simple ones, such as the fax. Such a policy should cover how and why to use each ICT during the project. Don’t leave the rule-setting up to the team members. If team interaction trouble arises later, this policy can be modified and new rules set as necessary.

2) Monitor team interaction for 5 key potential problem areas and look for opportunities for improvement in ICT usage.

3) Recognize the need for supporting actions when you make a change. It is not enough to get new ICTs running. ICT changes need to impact participation and information processing capacity to impact project outcomes.
   a. Formal training makes a critical difference in developing motivation, especially for larger changes to integrated tools. Use informal training too.
   b. Persuasion skills trump command and control skills in importance for motivating members to make ICT use changes in virtual projects.

4) Make sure you have the right ICTs in your toolkit.
a. Know your ICTs: how to use them, at what points they are likely to breakdown, and how they are useful in the team’s work for individual members, the team, and the organizations.

b. Recognize the need for redundancy among your ICTs in your initial setup.

c. Consider having at least one option that can support relationship building and socializing.

TECHNOLOGY FACILITATION IN A VIRTUAL TEAM

“I’ve been working in computers for years, and only the simplest stuff works 90% of the time.” – a virtual team leader reflecting on technology facilitation

Interviews with 13 practicing virtual team leaders with experience in more than 20 organizations including more than half of the top outsourcing firms according to Information Week (McDougall, 2005) formed the data in this study. The interviewees had an average of five years of experience as virtual team leaders and ten years of experience as team leaders in general. They reported incidents from 30 projects spanning the breadth of the IS project domain from analysis/assessment and new systems design to larger BPR/change management efforts or ERP implementations. Many of the projects involved outsourcing or off-shoring. They served as the ultimate project leader in 14 (47%) projects and as sub-leaders in 16 (53%). The average budget reported was $625,000 per month. Shorter projects lasted four to eight months. Longer ones lasted two to five years.

Whether involved in virtual teams or not, most knowledge workers spend most of their time working virtually through ICTs; they do not do this well, and this is a key area for productivity improvement (Davenport, 2005).

OVERVIEW OF TECHNICAL FACILITATION PROCESS

This study looked at the process of technology facilitation within virtual team projects. Our findings on this process are summarized in Figure 1. Interviewees answered questions about this process: its triggers, the actions leaders take, the changes that immediately resulted from those actions, the impact these changes had on team outcomes and the beliefs and knowledge team leaders held throughout this process. We will overview the process first and then discuss each component in more detail.
Leader knowledge and beliefs are shown as the base of this model because they drive the entire process. VT leaders engage in monitoring actions throughout the team interaction process. These actions identify structural opportunities and problems with regard to information and communication technologies (ICTs). Following trigger identifications, VT leaders take actions to cause structural changes. The oval shaded area in the center of the model shows the structuring process as leader actions resulting in emergent structures. Structures are the rules and resources that constrain and enable team member behavior.

Leaders may directly manipulate technology, task, and people structures, and they may take supporting actions that promote appropriation of the existing or newly manipulated structures. In one case, a leader found problems arising from using email with group members in Asia who were not understanding the messages. To address this communication problem, he changed the work schedule to accommodate a new rule of having synchronous, phone meetings after any major discussion through email and persuasion the Asian team members to follow this rule. He had not added an ICT but emphasized new use of the phone. Relations improved and work became much more productive. In another case, a leader found the collaboration portal for the team was causing several problems. It had performance and access problems. Information could not be found. He developed a consensus that this tool was inadequate, assigned a team member to research new tools, acquired a new portal software, developed norms for using this new portal, trained the team on it, assigned a member to administer it, and mandated its use. Team interaction improved with the new tool in place, leading to less stress, better morale, more efficiency, improved communication, and better information processing capacity.

The leader’s actions lead to initial, emergent, low-level changes in technology, tasks, and people structures in the team. Over time and possibly with the aid of additional appropriation support actions, these low-level changes lead to higher-level emergent structure changes in
participation and information processing capacity. These changes are “higher-level” in that they presume the use of lower-level structures within team interaction.

Participation and information processing capacity form the core of how the VT leaders in this study viewed team interaction. Participation centers on the team members: 1) how they cooperate or express their willingness to work together, 2) how they coordinate information flows or are able to know when to send what, and 3) how they communicate or are able to transmit messages between each other. Information processing capacity centers on the information at the core of work: 1) visibility or having accurate, accessible information in shared information repositories, 2) manipulability or having information that can be jointly visualized and manipulated simultaneously by dispersed team members, such as jointly rotatable 3-D models or even screen-shared spreadsheets in which members share mouse movement and the ability to do “what-if” analysis, and 3) exchangeability or having information in forms that can easily transfer intact virtually from member to member. These are the main aspects the leaders monitored to assess the need to begin technology facilitation. The following sections address the pieces of this process.

Recognizing Triggers

The triggers involve problems and opportunities (Figure 2). Only 12 of the 52 (23%) technology facilitation critical incidents collected had an opportunity focus. The general attitude we found was “if it’s not broken, don’t fix it.” Leaders focused on problem triggers much more than opportunities.

Basically, a virtual team leader monitors team interaction to uncover triggers, focusing primarily on participation and information processing capacity. When exceptions or difficulties appear, the leader perceives a problem trigger. These come in five varieties (most predominant listed first):
1) Externals to the team interfering. These include organizational policies that restrict ICT choice and permissions or pressure for changes exerted by higher management or the client on project team members. These problems put pressure on coordination and can lead to changed participation and information processing capacity needs.
2) Tool inadequacies. These include missing but needed ICT features, information overloads in ICTs such as email, and ICT accessibility and reliability breakdowns. These problems often impact information processing capacity and communication within participation.
3) Trust and relationship breakdowns. These involve team members not getting along, members “going dark” and refusing to respond, and general cooperation problems. These seem to be the most dangerous. They short-circuited the whole team’s interaction process in three incidents.
4) Interference of group structure. These include changes in the team membership over time as members enter or leave, organizational or international culture issues among team members,
and issues related to the physical distances and time-zone dispersion of the team members. They appear in participation, often in coordination issues.

5) **Member knowledge.** These include issues in which team members do not know enough to use one or more ICTs effectively. This can result from inexperience or from belief that the tool is not useful. These show up in participation, often in communication issues.

Note that in many problem-focused incidents several of these problems occurred simultaneously.

Opportunity triggers rely on **leader knowledge.** The VT leader conceives of ways to improve participation or information processing capacity within the team by changing the ICTs being used or the ways in which one or more ICTs is being used. In one incident, a leader got the team to acquire and install an eMeeting tool that enabled a critical client meeting to include the larger team without overwhelming the client. This was a large success and required training and pilot-testing the new ICT mid-project. Such opportunities can lead to improvements in participation or information processing capacity while avoiding the breakdowns in team interaction that define problem triggers.

To encourage successful use of opportunity triggers, VT leaders must know the specific ICT options available to the team in their toolkit and on the market. They need to know how easy these are to use and what it will take to motivate team members to use them, and they need to know their team members’ levels of comfort and knowledge using ICTs. Even within the problem-focused incidents, this knowledge played a key role enabling leaders to effectively diagnose situations and craft solutions.

**Taking Action**

Having recognized one or more triggers, the virtual team leaders took one or more actions. A virtual team leader takes two basic types of technology facilitation actions: 1) actions that **directly manipulate team structure** and 2) actions that **support the new or changed use of ICTs.** Directly manipulating structure involves either ICT changes or corollary changes in task or people. The ICT direct manipulation actions involve acquiring and implementing new tools, implementing unimplemented existing tools already in the team’s ICT toolkit, or modifying implemented existing tools. In some cases, we observed leaders taking corollary actions in addition to the ICT actions. These corollary actions focused on tasks and people, directly manipulating the project schedule or tasks, setting new rules for interaction, relocating team members, or redefining member roles in order to make the technology facilitation work. All of these **direct manipulations hinge on supporting actions for success.**

The supporting actions are initializing, persuading, training, and enforcing rules. The initializing actions involve setting up team interaction, designing the communication plan so that it is clear
about how and why to use the ICTs in the team’s toolkit, setting up the ICTs, and being the first to use the ICTs (especially complex, new ones). Only 17 of the 30 (57%) projects included a formal orientation process that included initializing actions. This is a large, missed opportunity, particularly in large projects with high pressure and members from multiple organizations with a variety of ICT use habits. Several reported problems traced to failure to take charge and commit initializing actions during the ramp-up phase of projects.

Training and persuasion served a critical role. We found effective leaders provided these supporting actions to ensure their facilitations’ success. Training spanned a variety of possibilities. Formal trainings were often at the beginning or early stages of the project, but we also heard three instances of stopping team interaction and flying everybody in for a formal, sit-down event mid-project. Informal training included on-going modeling of effective use of the ICTs and reminders of how to use the ICTs as well as using other team members collocated with members having trouble as ICT trainers or tool champions. In the three projects where we observed formal mid-project re-orientations, they were particularly critical for introducing or re-introducing large, complex development support or integrated team tools, such as collaborative team OO development tools or collaboration portals that fundamentally changed the way members would be passing messages, archiving data, and versioning documents. Overall, training efforts provided a platform to convey both how to use the ICTs and how the ICTs would be useful to the team members, team, and organizations if used.

Persuasion required soft skills – discussing the use of the ICTs with the team to convince them that the effort to use the tools outweighs the costs, establishing expectations of regular use of the ICTs during work, and reminding members of the motivation for using the ICTs. Team members were not automatically convinced of the need to use new tools or change their use of existing tools, simply because leaders told them it was necessary.

If team members are not persuaded to use ICTs, they are unlikely to use them in a virtual team. Classic management techniques involving enforcing rules through mandate did not seem very effective in the incidents studied. Leaders pursuing an enforcement strategy alone had to fly everyone in for a “talking to” in three incidents. Such meetings are very costly and require team interaction to stop, causing lost productivity.

As a base, members must have a clear conception of how to use ICTs and how the ICTs will be useful to them. These thoughts provide the motivation to change. This comes through training. When training ends or does not convey this whole meaning, persuasion becomes critical. Only 25 incidents (48%) included training or persuasion actions. Training, even informal, offers an ideal setting for more easily setting up the base motivation for making ICT use changes. Not using training actions appears to be a serious mistake.

The more organizations involved in a project and the more physically distant, the more likely entering team members will have different preferences and habits regarding even the simplest and most “comfortable” ICTs: the phone and email. Leaders reported problems originating even from these two. Phones may be shared among cubicle-mates and therefore unavailable except with careful forward planning. Several leaders reported email breaking down in teams with more than five or seven people due to overload, problems tracking down correct versions of attachments, or inability to send large enough files. When even the most “comfortable” ICTs breakdown, the leader needs to create better participation and information processing capacity options. Overcoming members’ high comfort level requires persuasion.

The ability to persuade team members virtually critically differentiated the most successful technology facilitation incidents from the others.
CHANGES AND OUTCOMES OF TECHNOLOGY FACILITATION

A technology facilitation can go well or poorly (Figure 4). Other than gut feelings, several key questions help determine whether a technology facilitation is effective.

1) Have improvements in participation resulted?
2) Have improvements in information processing capacity resulted?

Participation and information processing capacity goals of technology facilitation have been described in the preceding sections. These are higher-level changes that take place in team interaction as a result of technology facilitation. The lower-level changes simply modify tasks or people, implement ICTs, or modify ICTs. It is not enough to have low-level change. In several incidents, leaders got their teams to install and make new ICTs operational, but the ICTs never had an impact on team interaction or outcomes. Supporting actions, particularly training and persuading, play a critical role in making sure these lower-level changes convert into improvements in team interaction that will feed better project outcomes. If change stops at the lower level, leaders have two choices. They can try additional supporting and corollary actions or they can decide to start another cycle of the process and take new direct technology manipulation, corollary and supporting actions.

When successful, technology facilitations resulted in a variety of outcomes including saving troubled projects, making budgets, innovating company processes, higher quality products, and higher client satisfaction (Figure 5). In one case, the leader came into an ailing project involving multiple organizations, some off-shore. The previous lead could not handle the senior staff in the other organizations. The new leader spent time assessing the situation, realizing there were tool inadequacies (too much reliance on email), information visibility problems (shared task information could not be accessed easily), internal group structure problems (dispersion and team size made email unworkable as the main information sharing device), and cooperation problems (private communications between members that should have been shared and differing views on task information led to conflicts). His central technology change was centralizing all of the task information in an Excel spreadsheet and placing that spreadsheet in a shared teamspace where all members could view it any time and update their portions. He also set some new rules and engaged in persuasion actions to
encourage open communication. He attributed this seemingly simple solution with resolving the conflicting data trouble and resultant cooperation problems, improving members’ accountability to each other, improving morale, and saving the project from failure. As he put it, “the business would have pulled the plug… although this was very strategic,… there comes a time when there is no more option… no more millions to throw at it or no more time.”

Technology facilitations led to a variety of intermediate outcomes in process and people as well as key project outcomes in product quality, client satisfaction, and money. Two key process outcomes, information processing capacity and participation, fed the third, time (efficiency). If information processing capacity and participation improved, efficiency also tended to improve. Among team members, ICT use changes also had intermediate impacts. Some leaders reported ICT changes feeding either improvements or decreases in trust and morale, accountability, and learning.

In one of the more creative incidents, a leader alternately physically relocated herself to each side of a standing teleconference between technical and business sides on the project team for an introductory period in order to build trust and morale. At the same time she took other actions to retrain the members and persuade them to change their habits during the teleconferences. Her strategy worked, and the team began to use the teleconferencing without whispering and sabotaging the other side. In another case, the team’s discovery of a more effective file sharing technique involving innovative, regimented FTP use between India and the U.S. led to the host organizations changing their global policies for all teams. These intermediate outcomes ultimately led to project completion and success.

OTHER GUIDELINES

Have the Right Tools in Your ICT Toolkit

Every virtual team has an ICT toolkit. Invariably, they will have phone, audio conferencing of some sort, and email in this kit as options for the team to use. Figure 6 shows the percentages of projects in which leaders reported each ICT present as an option. There were a few additional ICTs found that are not listed, they included WIKIs and a few custom tools.

The ICT toolkit is the set of information and communication technologies virtual team members have readily available to use. Notice that several of the ICTs in the chart are similar or provide duplicate benefits. Groupware / teamspaces, for instance, include file sharing capabilities most of the time, just as file servers do. Having both in the toolkit is good. Two incidents involved more complex file sharing systems failing and the leader stepping in with either a Web-based or FTP-based alternative in the knick of time. **Having redundant options ensures you can make things work in a pinch.**
Some leaders took control of this toolkit, analyzing their ICT resources up front and filling gaps proactively. These efforts to design and setup team interaction with ICTs in mind paid off in fewer problems later on and easier solution of problems when they arose. **If you can train the team on this toolkit up front, do it.**

Leaders had different models concerning which ICTs were useful for different team interaction needs. Among the more interesting and common key beliefs found, IM played a special role in dealing with some of the most dangerous virtual trust and relationship breakdown problems. It can serve as a virtual “water cooler” as one leader put it. In four projects, it served this role and helped build and maintain the interpersonal capital necessary to convert lack of trust between team members into a more productive relationship. There does not seem to be another tool that works so well for this critical purpose. Phone and other synchronous tools were reported to not work as well. The other option leaders took was flying everybody together for face-to-face meetings. These were very expensive. If this makes sense to you and your team members have the knowledge and capability to use IM, make IM a safe area for your team to socialize and send each other tasteful jokes and short questions. It can be a critical piece of making successful virtual cooperation.

**FINAL THOUGHTS**

You, the participants in this study, were the starting point for helping develop this specific model of technology facilitation. It will help other virtual team leaders who also struggle to make ICTs and virtual collaboration work. Thank you for your participation!

This model will also help the academic community. Often, academia relies on models developed with student data or sometimes, simply based on conceptualization. This model is grounded in your experience of real world projects today. It presents key notions within the
team interaction process, including defining participation and information processing capacity as key goals of technology facilitation. Future research will focus on the key actions found and their relationship to success or failure, how to train virtual team leaders to be successful and more proactive in seizing opportunities before they lead to stoppage of team interaction, and development of assessment instruments that can help identify individual leaders’ technology facilitation strengths and weaknesses for more targeted training. The results should also send a strong message to the ICT vendors about design. Tool inadequacies appeared in 37 of the 52 incidents (71%).

Technology facilitation can save troubled projects and make team interaction work better in working projects. This study provides a basis for further research into technology facilitation and how to make it successful. With better technology facilitation projects can be less stressful and team members can spend more time enjoying what they do, perhaps spending quality time with their families rather than working late-nights on weekends due to missed deadlines and failed virtual team interaction.

FURTHER INFORMATION

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