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Adaptations that Virtual Teams Make so that Complex Tasks Can Be Performed Using Simple E-Collaboration Technologies

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ABSTRACT

Using the theoretical lens of compensatory adaptation theory, this study examines how organizational problem-solving teams adapt to lean media and effectively communicate. We examined several successful virtual teams using a bulletin board as their primary communication medium to perform complex process improvement tasks in their natural business environment. Although some established theories predict failure using lean media, savings from use of simple e-collaboration technologies provide motivation for conduct of virtual teams. Compensatory adaptation theory argues that e-collaboration technologies often pose obstacles to communication, and yet also lead to better team outcomes than the face-to-face medium. This study provides support for that theory. Members of the virtual teams reported adapting their communication to be more focused, clear, precise, neutral, concrete, concise, persuasive, considerate, and complete in order to overcome the obstacles posed by media of low richness. As a result of those adaptations, the teams perceived better quality and achieved success of the team outcome.

Keywords: action research; asynchronous electronic communication media; compensatory adaptation theory; e-collaboration; process improvement; virtual teams; qualitative methods

INTRODUCTION

Business process improvement in dispersed organizations creates special problems for information systems (IS) management. The multiple cultures and local goals of global organizations add to the problems of geographically and temporally distributed IS management. A single stake-

holder or group cannot explore business process interconnectedness without collaborating with other stakeholder groups. Such collaboration requires knowledge transformation and transfer across organizational boundaries; therefore, the best team of people from an enterprise with the variety of expertise necessary to address a

complex problem may be geographically and/or temporally distributed across the organization (Carlile & Rebentisch, 2003; Gasson, 2005). Internal competition for resources may provide one reason for the high failure rate of business process improvement projects, generally reported at 70% (Malhotra, 1998). The varying availability of team members, the conflicting priorities of functional task performance with business process improvement, and the high cost of convening process improvement teams combine to provide a *disincentive* to calling a series of face-to-face meetings.

Increased globalization of enterprises combined with widespread adoption of simple, low-cost, asynchronous e-collaboration technologies (e.g., bulletin board, e-mail) for organizational communication provides *incentive* to attempt increasingly complex problem solving with virtual teams. Virtual teams allow “organizing work groups by electronic workflow, not physical location” (Dutton, 1999, p. 132). If complex business process improvement activities could be conducted using e-collaboration, especially asynchronous e-collaboration, the potential to reduce competition for resources by reducing travel time and increasing the communication window to 24/7 improves the ability to address the multiple priorities of daily business and business process improvement simultaneously.

The knowledge that other virtual process improvement teams have been successful (DeLuca, 2003; Kock, 2005c) and lessons learned from those teams may be what is needed to provide confidence to organizations that their efforts would come to fruition. But we need to understand how these virtual teams are successful, especially how they overcome the difficulties of using asynchronous electronic communication media (AECM), to manage such

initiatives effectively. Existing theories of information processing in organizations do not scale well to the complex forms of knowledge integration required at the boundary between the diverse teams found in virtual organizations. Thus, we investigate a new theory of communication behavior, compensatory adaptation theory (CAT) (Kock, 2005b).

We believe it is difficult to do research on social phenomena without changing the phenomena by studying it, so we study interactively and report our interactions. A goal of this paper is to report on a study of virtual process improvement teams in their natural environment that used AECM to redesign their chosen business processes. We report on one cycle of a study that employed a canonical action research approach (Baskerville & Wood-Harper, 1998), using a postpositivist epistemology, with primarily qualitative methodology, reported using applicable elements of a structure suggested by DeLuca (2005) and DeLuca and Kock (forthcoming). Postpositivist is a term used by Lincoln and Guba (2000) to indicate, among other things, use of a different type of hypothesis other than a null hypothesis and support of hypotheses with qualitative evidence. The hypotheses in this study are based on the theoretical lens of CAT and the relationships suggested by it, explained in the next section. We also operationalize a key construct, compensatory adaptations.

COMPENSATORY ADAPTATION THEORY

Effective Asynchronous Electronic Communication

To be effective, virtual process innovation teams must negotiate and define best practices (Malhotra, 1998). Team members

must manage ambiguity, uncertainty, and equivocality to communicate regarding organizational knowledge about best practice (Zack, 2001). Yet virtual communication channels may increase ambiguity and equivocality because of a lack of media richness (Daft & Lengel, 1986). Various media differ in the degree to which they can convey the cues that make information meaningful to human beings. According to the media richness theory, effective organizational managers prefer “rich” media, such as face-to-face (FTF) or teleconferencing, for equivocal communication because they permit the use of a wide variety of verbal and nonverbal cues, and “lean” media that may support fewer social cues for unequivocal communication (*ibid.*). Nonverbal cues are referred to by Bavelas, Black, Chovil, and Mullet (1990) as vocal or paralinguistic cues (tone, emphasis, rhythm, rate, hesitation), and bodily cues (expressions, gestures, movement, direction of gaze). Lengel and Daft (1988) predicted communication failure for complex problem-solving efforts (i.e., process improvement) that used a lean medium (i.e., bulletin board), because such a medium would lead to “data starvation” and “too few cues to capture message complexity” (p. 227).

Yet empirical research results are inconclusive on the effect of AECM and technologies upon communication effectiveness (Miranda & Saunders, 2003; Rice, Kraut, Cool, & Fish, 1994; Riva & Galimberti, 1998). This may be because media attributes are only part of the picture. Computer-mediated communication is often viewed solely as a process of information transfer, where information content becomes a reified object, missing the connections with human knowledge and social aspects of human communication (Riva & Galimberti, 1998). To fill the

theoretical gap, we need to account for the human and socially-situated processes that make e-collaboration effective (Kock, 2005a; Majchrzak, Rice, Malhotra, King, & Ba, 2000; Miranda & Saunders, 2003; Rice et al., 1994).

Social factors, such as sponsorship by influential managers or the need to conform to a prevailing genre of communication, are a greater predictor of success or failure than the leanness of the media supporting specific tasks (Ngwenyama & Lee, 1997). Dutton and colleagues indicate that successful innovation is as much political, economic, and social processes as it is rational problem solving (Williams & Edge, 1996). Equivocal tasks, such as business process innovation, require the “softer” human abilities: judgment, creativity, knowledge, interpretation, identification of knowledgeable peers, and conformance to social norms (D’Ambria, Rice, & O’Connor, 1998; Gasson, 2005; Miranda & Saunders, 2003; Rice, 1992). The use of specific genres of communication such as e-mail or voice communication locate these utterances within a context of norms, authority, and interpretations that exceed the limitations of the media form (Davidson, 2000; Lee, 1994; Yates & Orlikowski, 1992). The selection of specific media may be made on the basis of minimizing disruption of daily business, or using media that are familiar to team members, or sponsored by powerful stakeholders, rather than on the basis of rational fit with task requirements (El-Shinawy & Markus, 1998; Kock, 2005b). It is therefore argued that social factors such as social norms, authority relations, and genre norms influence media choice significantly more than media or task characteristics.

Given that asynchronous electronic communication media (AECM) are familiar, sponsored, and readily available

for virtual team use, the limitations of lean AECM must be overcome or compensated for in some way in order to effectively perform complex tasks (Kock, 2005b; Majchrzak et al., 2000; Markus, Majchrzak, & Gasser, 2002).

Kock (2005b) observed individual team members adapting their communication behaviors to compensate for the deficiencies in the “richness” of the communication channel with which they have chosen to work, and developed the compensatory adaptation theory (CAT), positing the processes shown in Figure 1.

Virtual team members perceive limitations or obstacles to effective communication, and adapt their behavior to overcome the resulting potential communication ambiguity in order to be successful in achieving their work goals. The links between processes involved in Figure 1 provided the basis for the central research question and more detailed hypotheses. Based on CAT, the central research question (CQ) is

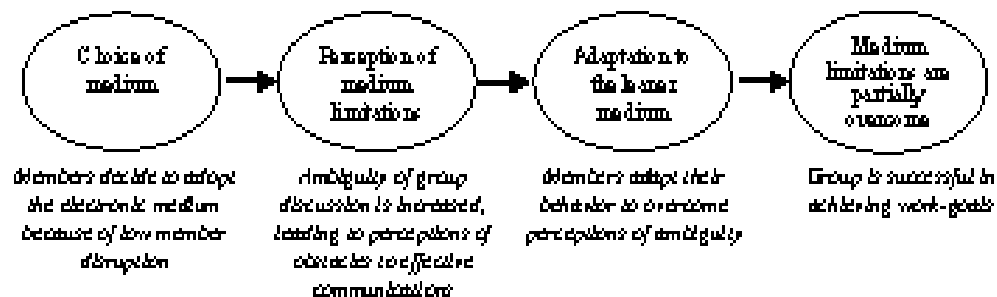
CQ: Can process improvement teams using lean asynchronous electronic communication media be successful and, if so, can compensatory adapta-

tion theory be used to explain the success?

Obstacles to Communication Effectiveness

CAT posits that team perceptions of media limitations or low media naturalness lead to perceptions of increased ambiguity and increased cognitive effort needed to interpret team communications. Team members will therefore perceive constraints on the naturalness of AECM as obstacles to effective communication. In a study by Graetz, Boyle, Kimble, Thompson, and Garloch (1998), mental demand, temporal demand, effort, and frustration were all more than 50% higher using e-collaboration than FTF, supporting the assessment of “low” naturalness for AECM and consistent with earlier studies (Daft, Lengel, & Trevino, 1987b; Rice, 1992; Rice and Shook, 1990). One explanation for the perceptions of low naturalness of AECM, offered by Kock (2004) is that the human species has been biologically designed (i.e., evolved, in a Darwinian sense) for FTF communication. He summarizes the biological basis of FTF communication into the following characteristics: coloca-

Figure 1. The compensatory adaptation process (adapted from Kock, 2005b)



tion, synchronicity, body language, facial expressions, and hearing and speech; all of which are lacking when communicating with a lean AECM.

The *media naturalness principle* of CAT states that:

Individuals who choose to use electronic communication tools experience increased cognitive effort and communication ambiguity proportionally to the degree to which the tools suppress elements that are present in the face-to-face communication (e.g., synchronicity, ability to convey/perceive nonverbal communication cues). (Kock, 2005b, p. 46)

This leads us to our first hypothesis, expressed in a form consistent with Lincoln and Guba (2000) and Briggs and Dean (2005):

- H1. Teams who use a lean, asynchronous electronic communication media for process improvement will perceive obstacles to communication effectiveness compared to their experience with face-to-face communication.

According to media richness theory, there are four reasons for richness differences (Lengel & Daft, 1988): (1) immediacy of feedback; (2) nonverbal cues; (3) person focus on a single receiver; and (4) language variety. With the goal of exploring how individuals compensate for deficiencies in required-use media, we have adapted the four criteria to fit with a socially and contextually-situated view of mediated communication. An analysis of the literature revealed that most discussions related to media naturalness build on some variation of the following three dimensions of media richness: interactivity, channel capacity and

adaptiveness (Kahai & Cooper, 2003; Kock, 2004; Short et al., 1976). We relate these three categories to the four categories of traditional media richness theory, assessing the social implication of each dimension, to derive a typology by which the perception of obstacles to communication effectiveness may be operationalized:

Interactivity is the potential to *obtain immediate feedback* from other communicants. Synchronous communication media, such as telephone or interactive team support systems typically provide a high degree of interactivity, even though individuals are not colocated, that increases the user's perception of social presence (Kahai & Cooper, 2003; Murthy & Kerr, 2003; Short, Williams, & Christie, 1976). Lean AECM are, therefore, predicted to be perceived as providing low levels of interactivity.

Channel capacity is the ability to transmit a high *variety of language and social cues (both verbal and nonverbal)*. A lack of nonverbal cues (e.g., body language, facial expressions, volume, tone) leads to ineffective communication, as gestures, eye contact, and tacitly-shared sociocultural indications of social presence are lost (Short et al., 1976). Lean media are, therefore, predicted to be perceived as supporting a low variety of language and social cues.

Adaptiveness is the potential to *acknowledge, adapt, and personalize messages* of a particular communicant. Impersonal communications lead to low perceptions of social presence (Daft et al., 1987b). Impersonality may be manifested not only as communications that are directed at a specific individual (Murthy & Kerr, 2003), but also as acknowledgement and inclusion of an individual's contribution to team discourse and decision-making processes (Riva & Galimberti, 1998). The

predictions of adaptiveness and personalizability would be low, however the written aspect of some lean media may enhance acknowledgement of an individual's contribution by providing a historical record of contributions.

Compensatory Adaptations to Communication Behavior

The obstacles perceived from differences in interactivity, channel capacity, and adaptiveness of lean ECM (when compared to richer media or FTF communication) must be overcome or compensated for in some way in order to communicate effectively. Studies by Bavelas et al. (1990) on equivocal communication used written media because people adapted to the limitations of the written media and denoted "information that might otherwise be conveyed paralinguistically" (without losing the information as one might in a transcription) (p. 98). A study by Gasson and Elrod (2005) indicated that managers used e-mail or written media to formalize procedures when these might otherwise be interpreted equivocally.

Evidence from Kock (2005b), DeLuca (2003), and DeLuca and Valacich (2005) shows at least two patterns of behavior occurred to communicate effectively: an increase in care taken to compose and process messages, and a decrease in the number of words per minute that can be effectively communicated. Compensation for lack of language variety is made by use of a "shorthand" language that is grounded in common sociocultural perspectives (Boland & Tenkasi, 1995; Davidson, 2000). These compensations are addressed by CAT in the second and final theoretical principle, the compensatory adaptation principle, which states that:

Individuals ... engaged in collaborative tasks who choose to use electronic communication media tend to compensate for the cognitive obstacles they perceive as associated with the lack of naturalness of those media, which leads those individuals to generate ... outcomes of the same or better quality than if they had interacted solely face to face. (Kock, 2005b, p. 47)

The second and third hypotheses follow from this principle. The third hypothesis addresses "outcomes" and is explained in the next section. The second hypothesis addresses the adaptations made as follows:

- H2. Teams who use a lean, asynchronous electronic communication media for process improvement will perceive making compensatory adaptations to their communicative behavior compared to their experience with face-to-face communication.

Compensatory adaptations are not currently operationalized in the literature. It is a goal of this study to provide an operationalization based on analysis of the data. We will initially capture the perceptions of adaptations made as a response to the communication obstacles using the same typology as for the obstacles: interactivity, channel capacity, and adaptiveness.

Success of the Team Outcome

The notion that "outcomes of the same or better quality" result from media obstacles cannot be explained by either media richness theory or social presence theory. CAT fills this theoretical gap by employing an explanation from psychological literature: humans will recognize the existence of communication obstacles posed to them (Dobzhansky, 1971; Jung,

1968; Pinker, 1997), overestimate the amount of cognitive effort associated with a task, and compensate for the perceived associated cognitive effort (Pinker, 1997; Schacter, 2001). The compensations affect the outcome as discussed below.

In the context of a business process improvement effort, a successful team “outcome” is a redesigned and partially or fully implemented business process. To achieve an effective redesign, teams historically have employed a series of FTF meetings “rich” with nonverbal cues. Nonverbal cues enable intersubjectivity: a shared knowledge that operates at a tacit level of understanding. So, it would seem that teams using a lean AECM would be lacking the necessary variety and cues. Counterintuitively, there may be *advantages to an absence of nonverbal cues*. For example, various cultures interpret nonverbal cues differently, as do men and women from the same culture, which may provide an obstacle to effective communication. The virtual elimination of nonverbal cues may change the communication in ways that are more directed to the success of the team outcome. Team members may choose (1) to eliminate or otherwise disregard the distracting messages given by nonverbal cues found in FTF situations; and (2) to enhance messages to capture task-directed cues in writing.

Although possessing common team language may help team members communicate more efficiently, there may be a disadvantage in the resulting tendency to reduce the exploration of alternative courses of action (Flor & Hutchins, 1991; Rugs & Kaplan, 1993; Wilson & Canter, 1993). The performance of complex tasks calls for “requisite variety” (Ashby, 1956): environmental variety must be matched with variety within a system attempting to

regulate itself against that environment. Logistical obstacles to constructing a diverse team may be overcome by constructing a virtual team, where people from different departments, organizations, time zones, and shifts may all meet. Adaptations that participants made to use a lean AECM to effectively communicate with diverse team members may contribute greater quality of individual contributions; greater processing of teammates’ contributions; and, thus, to the greater success of the team outcome (DeLuca, 2003; DeLuca & Valacich, 2005; Kock, 2005b;). Ocker, Fjermestad, Hiltz, and Johnson (1998) studied teams using various media combinations. They found that team outcomes from teams that included lean electronic media in the mix were of the same or higher quality than FTF teams. This leads to the final hypothesis:

H3. Teams who use a lean, asynchronous electronic communication media for process improvement will have greater success of the team outcome than teams who use face-to-face communication.

Improved outcome or “success” in the context of the business process improvement teams conducted in this study is defined as partial to full implementation of the redesigned business process within 6 months, with observable gains in process quality and productivity. Teams that complete the redesign process by generating a process redesign, but do not implement any of the new process are not considered a success.

We operationalize the concept of success in terms of perceptions of effectiveness, efficiency, and quality as they contribute to success.

RESEARCH SITE AND METHOD

Research Site

This study focused on the communication behavior of four virtual teams from an educational services organization, studied in their natural environment. The organization provides professional care to approximately 2,000 students with special needs and their parents, teachers, and support staff. Their customers are school districts and vocational schools with approximately 100,000 students, 8,500 teachers and principals, and 1,500 nonpublic students. Each team was led by one individual from a functional area that had identified their highest priority problem, and the business process involved. All processes chosen involved improving quality of, and timelines for, various communications among stakeholders. The teams were cross-functional, with from 9 to 11 members. The 41 process-improvement team members represented approximately 400 teachers, 30 supervisors, and 400 support staff, as well as service providers and clients.

Team members were under severe time constraints as the study was conducted during the press of peak business. Team members were college graduates: on average with advanced degrees, had experience with face-to-face improvement teams, and were interested in performing business process improvement as part of a virtual team. Most team members were familiar with one another and, in most cases, within proximity to arrange face-to-face communication if desired.

Research Methods

This study reports on one cycle of a larger ongoing, traditional (canonical) action research study (Baskerville & Wood-

Harper, 1998) following recommended guidelines (Baskerville & Myers, 2004; Davison, Martinsons, & Kock, 2004) to investigate virtual teams' use of AECM for actual complex process improvement tasks. Access to an Internet-based bulletin board commonly used in educational environments was provided by the researcher, and was the primary mode of communication for the virtual teams in this study. Teams agreed to post any other pertinent communication that may take place outside of the bulletin board.

In addition to the electronic bulletin board, the teams used team e-mail for alerts to check and contribute to the bulletin board. Half of the teams also chose to use file sharing to separately post summary documents that were also included as attachments in the bulletin board. Only team members, the project manager, and researchers had access to the bulletin board, file sharing, and were on the team e-mail list.

As it was a goal of the study to conduct the teams in a natural environment, the process-improvement tasks were chosen by each team from among their highest-priority problems. They invited additional team members from affected functional areas, including customers, to participate in the team discussions. All business process improvement tasks were considered complex and all teams were cross-functional. All teams attended an introductory session that reviewed the technology to be used, the problem-solving phases and success factors learned from conduct of previous teams. Team leaders received an additional private session to review the technology, and process and answer any additional questions regarding leading a team.

Teams followed a typical structured process (Kock, 2005c) that further subdivided the three phases of problem and

process identification, change identification, and business process redesign into nine subtasks. The project manager and team leaders guided their teams through the process with occasional assistance from the researcher. The team “outcome” was a redesigned business process.

At the end of the business process improvement process, each team member was interviewed to explore the relationships among obstacles to communication posed by the media, adaptations to communication behavior, and success of outcomes. An open-ended and neutral question was used not to induce a particular answer (Rosenthal & Rosnow, 1991; Yin, 1994). The primary source of data was the responses to the following question:

In order to effectively use asynchronous electronic communication media, what adaptations did you make from the way you would communicate when face-to-face?

Responses to the question were recorded and coded into consistent, semantically equivalent phrases. To improve the reliability of the summaries, data were coded independently by two different researchers, or “raters,” who then conferred on all disagreements, including both missed and variably interpreted statements, and were able to jointly arrive at 100% agreement. Perceptions that were provided from at least half of the teams were reported in the Results.

Since CAT is relatively new, and the “adaptation” component is not widely operationalized in the literature, we wanted to explore the strength of the perception that adaptations were made to communication behavior by supplementing the primary qualitative data with supportive quantitative

data (Creswell, 1994, 2003; Ledford & Mohrman, 1993). A small scale was developed to this end, accompanied by a seven-point Likert-like “response scale” where seven is strongly agree and four is a neutral midpoint. Short scales of two to five questions have been shown to yield acceptable reliability measures (Moore & Benbasat, 1991). The scale was developed as recommended by Moore and Benbasat (1991) following the stages: item creation; scale development; and instrument testing in a two-round card sorting technique implemented similar to Nambisan, Agarwal, and Tanniru (1999). Cronbach’s alpha (Cronbach, 1970), which is “fairly standard in most discussions of reliability” (Moore & Benbasat, 1991, pp. 204-205), was 0.78. This falls in the “acceptable” range for reliability of a scale (DeVellis, 1991; Nunnally, 1978). The three statements that compose the scale for compensatory adaptations follow:

- a. In order to effectively use ECM, I made changes from the way I would communicate FTF.
- b. I adjusted how I would convey a thought when using ECM.
- c. In order to communicate using ECM, I had to compensate for not being FTF.

As a summary statistic of adaptations, a chi-square (Rosenthal & Rosnow, 1991) was computed on categorical data generated from placing responses from open-ended questions into one of three categories: (1) more compensatory adaptation reported to communicate via ECM as compared to FTF; (2) no compensatory adaptations reported; or (3) less compensatory adaptations to communicate via ECM as compared to FTF.

For the adaptations hypothesis (H2), the chi-square data, the measure from the adaptation scale, and the coded responses will be integrated using triangulation, “the combination of methodologies in the study of the same phenomenon” (Denzin, 1978, p. 291), The intent of using mixed methods and triangulation is to ensure the variance “measured” is not due to the method (Campbell & Fisk, 1959), to seek “convergence of results,” however, it is also possible that “different facets of a phenomenon may emerge” (Creswell, 1994, p. 175 in Greene, Caracelli, & Graham, 1989).

“Success of the team outcome” was determined as in Burke and Peppard (1995). In the context of the business process improvement efforts conducted in this study, success is defined as partial to full implementation of the redesigned business process within 6 months, with observable gains in process quality and productivity. A team that completes the redesign process by generating a process redesign, but does not implement any of the new process is not considered a success. Success was reported by the project manager.

RESULTS

In response to the open-ended interview question, participants revealed the relationships among obstacles perceived (H1), the adaptive behaviors engaged in to compensate for the perceived obstacles (H2), and the effect the behaviors had on their communications and thus on the success of the team redesign (H3). The detailed results follow, organized by hypotheses.

Obstacles to Communication Effectiveness

H1 investigates obstacles to communication effectiveness, which are organized as follows:

- a. Interactivity (lack of immediate feedback).
- b. Channel capacity (variety of social cues and language).
- c. Adaptiveness (personalized messages, written acknowledgement, and inclusion).

Lack of Interactivity

There appeared to be a perception that asynchronous electronic communication media (AECM) reduce *interactivity* when compared to FTF communication. Team members were unable to argue their point as easily as in person:

Talking is easier because you have eye contact, body language, nonverbal.

unable to process changes quickly:

Less spontaneity. Can't type as fast as talk.

unable to get quick feedback:

In ECM delayed reactions mean frustration.

and are unable to quickly identify the need for a clarification:

Had to decipher people's thoughts without any other clarifications.

Although the expectation for “immediate feedback” for AECM was modified to “feedback within a few days,” the frustration is still evident.

Lack of Channel Capacity

The second category of obstacles to communication is *channel capacity*, indicated by lack of nonverbal cues. To some extent, team members were unable

to find symbols to represent language and social cues:

Talking is easier because you have eye contact, body language, nonverbal.

symbols to convey emotion (with the side benefit of increasing focus by eliminating emotional distractions):

Can't give 'death stare.'

They experienced obstacles to conveying pause, tone, and headshake:

Writing is perceived differently—[there is no] movement, inflection, tone.

obstacles to joking around in a manner that is understood and will not hurt feelings:

It's not clear [if someone is] joking or being flip...

and obstacles to handling/explaining an abstraction.

Lack of Adaptiveness

The final category of obstacles to communication effectiveness is *adaptiveness*, whereby messages or media are personalized or individuals are acknowledged. Social discussion is seen as a waste of time, providing an obstacle to attempting it:

I didn't see social/verbal interaction as important. It was easier to use neutral language.

Some of the effects of using a written medium are considered beneficial, such as being able to access and print any

team member's message at any time. This allows a member to spend more time on a message:

Think about phrasing to not attack or be defensive. Avoid misinterpretation and emotional response.

with the potential to acknowledge each individual contribution:

In FTF situations, strong personalities override. ECM gave space for the aggressive to have their say and still give others a chance. They don't dominate air time because there is no limit on airtime.

The size of the input box was seen by some as a limit on the length of a contribution, a perceived, not-to-exceed length:

The size of the input box made me think more concisely.

Compensatory Adaptation to Communication Behavior Responses to Lack of Interactivity

H2 addresses *compensatory adaptations of communicative behavior*. This section is organized by the responses to each of the three obstacles to effective communication that were identified above: interactivity, channel capacity, and adaptiveness. Participants indicated compensating for the inability to obtain immediate feedback (or taking advantage of it). They compensated in a variety of ways, as shown in Table 1a, *Compensatory adaptations: Interactivity*, which partially summarizes responses from the open-ended question:

Table 1a. Compensatory adaptations—interactivity

	→ H1	→ H2	→ H3
Perceived obstacles to effective communication	Perceived need/obstacle/limitation (or benefit)	Adaptations to overcome obstacles	Effect on team outcome
Lack of immediate feedback	Not there to argue point in person	Make a more persuasive/powerful argument.	More time in wording.
Lack of immediate feedback	Less ability to quickly process changes and no embarrassment to make changes	Formulate, review, and revise.	More editing before send.
Lack of immediate feedback	Less ability to clarify a misinterpretation	More thought, choose words carefully	More editing, change wording to avoid misinterpretation.
Lack of immediate feedback	Cannot get feedback or make quick clarification	More complete contribution because cannot clarify.	More editing to make sure it is all there
Lack of immediate feedback	(Benefit—immediacy not expected)	Read, digest, respond	More time in reflection

In order to effectively use asynchronous electronic communication media, what adaptations did you make from the way you would communicate when face-to-face?

Participants indicated that they responded to the lack of interactivity by formulating, reviewing, and revising without embarrassment over the changes:

Liked the fact that I could 'see' my thoughts as I was thinking them and was able to 'self-correct' without having to be embarrassed by the 'ums' and 'uhs' that most of us have when we are trying to communicate our thoughts orally.

reducing ambiguity:

[When composing a message I] put myself in to the position of the receiver of the information to reduce ambiguity.

thinking longer to choose words that will not be misinterpreted:

Write clearer and not be misunderstood.

making a more complete argument because the ability to provide clarification is delayed:

Needed to capture thoughts in writing and tended to express a thought more fully all

Table 1b. Compensatory adaptations—Channel capacity

	→ H1	→ H2	→ H3
Perceived obstacles to effective communication]	Perceived need/ obstacle/ limitation (or benefit)	Adaptations to overcome obstacles	Effect on team outcome
Lack of nonverbal cues	Desire to convey cues. Lack of symbol.	Language and social cues captured in writing. (translated to text)	Find wording or symbol to convey the nonverbal.
Lack of nonverbal cues	Emotion not needed.	Take emotion out.	More editing to eliminate emotion.
Lack of nonverbal cues	Avoid emotional interchange – off task	Less emotional intensity/volatility/ judgment.	More editing to eliminate inflammatory language.
Lack of nonverbal cues	Lack of symbol	Used ... for pause.	Time spent considering wording and deciding on symbolic substitute for pause.
Lack of nonverbal cues	Lack of symbol	Used smiley faces for emotion.	Learn/use emoticons to soften language.
Lack of nonverbal cues	Lack of cues	“Easier” to write in neutral terms without cues.	Determine neutral language.
Lack of nonverbal cues	Lack of symbol for tone needed to avoid misunderstanding	Write clearly to capture tone in text, avoid misunderstanding.	More time wording to capture tone and /or avoid misunderstanding
Lack of nonverbal cues	Cannot see head shake to see if have agreement	Send/receive request electronically to simulate head-shake agreement especially for milestone or synthesis stage before moving on.	Additional messages sent/received.
Lack of nonverbal cues	Avoid accidentally hurting people’s feelings.	No joking or being flip.	Focus on task.
Lack of language variety	Less ability to handle “abstraction”	Chose language that was more concrete.	More time/effort composing contribution in concrete language.

at once, rather than the back and forth in a FTF interaction (avoiding the immediate inability to clarify/expand).

Choose words to compensate for nonverbals.

being more concise:

taking emotion out of the writing:

Type less than would say FTF.

The key is taking the emotion out. Try not to knee jerk (digest).

and responding electronically to others to simulate a headshake agreement:

taking intensity, volatility, and judgment out of the contributions:

Respond more to simulate head shake agreement.

Choose words very carefully, without judgment.

Responses to Lack of Channel Capacity

writing a more persuasive or more powerful argument:

Lack of nonverbal cues (less channel capacity) makes the ECM less natural than the face-to-face media. Participants reported responding to (or compensating for) the lack of nonverbal cues, as summarized in Table 1b, Compensatory adaptations—*Channel capacity*, Specific adaptations included:

Had to create more powerful arguments. Persuasive writers have the advantage vice charismatic in FTF.

writing with more focus:

attempting to determine if all team members were in concert with the most recent synthesis:

Focus, be concise, think, convey, type, change words, reduce words, want clarity.

As a leader, I summarized more frequently. It was a concerted effort to give feedback to move ahead.

being more concrete:

and using symbols:

Trying to be more concise, precise, concrete.

I just found ways to type (bold, !, caps) to replace some body language or voice intonations. ... for a pause; and being more neutral without cues ("effort to communicate neutrally").

eliminating joking:

Can't observe body, hand, facial expressions taken the wrong way, so [I write to be] less ambiguous.

Responses to Lack of Adaptiveness

attempting to capture desired cues in the writing:

Since the medium used was a written one, adaptiveness to individuals took an interesting turn. Both positive and negative effects were reported in the responses outlined in Table 1c, Compensatory adapta-

Table 1c. *Compensatory adaptations—Adaptiveness*

	→ H1	→ H2	→ H3
Perceived obstacles to effective communication	Perceived need/ obstacle/ limitation (or benefit)	Adaptations to overcome obstacles	Effect on team outcome
Lack of personal social messages	Not “waste” time with tangential or social discussion.	Applied a policy of self-editing in communications to ensure a focus on moving through task steps.	Changing normal thinking process.
Acknowledge contribution in writing	Public posting of written contribution motivates quality.	Write with more clarity of point.	More thought on writing clearly and providing quality input.
Effect of written media	Perceived limit on reasonable length of contribution as size of input box.	Be more concise; leave out some detail.	Reword to leave out rambblings or unnecessary detail.
Acknowledge contributions in writing	(Benefit – Access to a sequence of historical communication)	More likely to read and consider other team member’s contributions and responses to contributions	More open to other contributions. More appropriate response. Additional time spent in consideration.
Effect of written media	(Benefit – Availability of printing of written media)	Printed out contributions, see own in writing.	Review own contribution before submission

tions—*Adaptiveness*. When compared with face-to-face communication, participants reported the following effects:
giving more consideration to each individual written contribution:

I ‘listened’ (by reading) more closely to what others had to say. Could go back and reread, reformulate, and analyze the input.

reflecting longer on others’ contributions before responding:

Processed responses better.

writing their own points most clearly since it will be posted and reflected more on them:

Choose words more carefully, use less words, because they are ‘recorded’ and part of the overall project at the end.

tending to the social/emotional sensitivities of others:

Effort to communicate neutrally.

writing clearly to capture the intended tone in the text and to avoid misunderstanding:

Capture or eliminate tone. FTF there have been a lot of tone issues. If you make a mistake, you can't retract.

using smiley faces to compensate for media removal of personality:

Used emoticons smiley face for my personality.

Strength of Compensatory Adaptations

To further explore H2, the Likert scale response summary and chi-square analysis provide numeric auxiliary to the qualitative results. The results of the Likert scale response data, for a scale identifying whether there was a perceived increase in compensatory adaptations, yielded an average score of 4.6 on a scale from 1 to 7, where 7 is the strongest agreement and 1 the strongest disagreement. A 4.6 indicates a reasonable degree of agreement that adaptations were made. Chi-square analysis (Rosenthal & Rosnow, 1991) was performed by categorizing the qualitative responses into the three categories of increased/same/decreased perception of adaptations to communication behavior. The chi-square results are significant at better than $p < .001$, with a large effect size. Statistically speaking, the difference in categories is probably not due to chance. In short, 95% of respondents perceived adaptations they had made, an indication of much stronger agreement about making adaptations than is reflected in the numerical score from the Likert statement analysis.

The difference of the strength of the preinterview Likert data and the interview chi-square data is evident in comments indicating that, when interviewed, team members reported inadvertently offsetting adaptations made to communication behavior with a variety of factors. Some

team members offset the adaptation with a comfort level. "Nobody was looking at you ... no pressure to speak ... measure of effort includes reduced pressure ... more relaxed." Some team members have become quite adept at e-collaboration and make the adaptations almost without awareness. "Read, digest, respond is a norm. It has become second nature." "Typing to communicate is natural—I do it all day long." Several team members mentally offset the adaptations with perceived benefits of the ECM, such as presenting themselves more logically and coherently. "I got to sort through my thoughts and piece them together logically." Convenience of 24/7 access and avoiding time-consuming meetings and frustration were also sometimes perceived as offsetting adaptation to the ECM. "Overall it decreased the time commitment." Since participants had inadvertently offset adaptations with all of the above, support for the theory that users make compensatory adaptations to perceptions of communication obstacles is stronger than indicated in the Likert analysis score.

Success of the Team Outcome

H3 addresses *success of the team outcome*. All teams were considered successful by partially or fully *implementing* their redesigns within 6 months, as reported by the project manager. All teams completed the three stages and produced business process redesigns in approximately 1.5 to 2 months. Although caution should be used in drawing conclusions from a study of four teams, with *failure* rates for FTF process improvement teams generally reported at around 70% (Malhotra, 1998), for 100% of the teams in this study to be *successful* indicates that appropriate compensatory adaptations appear to lead to successful communication. The fact that teams complete their redesigns

during their busiest season provides strong support for this position.

When participants compared their face-to-face experience to use of e-collaboration, perceived increases in effectiveness, efficiency, and quality all contributed to the perceived increase in success of the team outcome (H3). Many of the compensatory adaptations made above contributed to the effectiveness of the team effort:

When FTF, I listen and not contribute. Now I make a commitment to contribute. Logon, more effort.

In writing, you can see the sequence.

More thought—more editing—perhaps more participation.

Made sure I read everyone's views and thoughts.

FTF rambles. With ECM you organize more, stay on task.

efficiency of the team effort:

Not interrupted.

ECM increased my effort in terms of preparing responses, but decreased the [net] time commitment.

It's easier to read than listen—more people in a brief period—efficient.

To get as far as we did on discussion board, we would have to meet ten times or all day—exhaustion.

better overall *quality* of the data exchanged, from increased effort:

Better quality.

I think about it more, write, rewrite, re-write.

Print out and take home and go over later.

More quality because it is posted.

Take your time—there's not a whole room of people waiting.

Maybe a little more time [to communicate my thoughts] compared to just talking, but higher quality.

Based on team members' perceptions, improved effectiveness, efficiency, and quality likely contributed to the overall success of the project. These patterns provide support for CAT, which argues that compensatory adaptations in media use lead to a successful team outcome.

DISCUSSION

The results generally support compensatory adaptation theory (CAT) (Kock, 2005b), which is the answer to our central research question, "Can process improvement teams using lean asynchronous electronic communication media be successful and, if so, can compensatory adaptation theory be used to explain the success?" Four different virtual teams from an educational services organization successfully completed complex tasks primarily using a simple electronic medium, a bulletin board, as their main communication medium, supplemented with e-mail for notices. Each team redesigned a business process and successfully implemented all or part of their redesign within 6 months. All four teams addressed an area of operational difficulty

Table 2. Summary of Results

Hypotheses	Evidence in support of CAT	Evidence questioning CAT
H1. Teams who use a lean, asynchronous electronic communication media for process improvement will perceive obstacles to communication effectiveness compared to their experience with face-to-face communication.	Obstacles to effective communication were perceived and organized into 3 categories – lack of interactivity, lack of channel capacity, and lack of adaptiveness.	Changed expectation for immediacy of feedback. Historical written record and availability of printing seen as a benefit of AECM over FTF.
H2. Teams who use a lean, asynchronous electronic communication media for process improvement will perceive making compensatory adaptations to their communicative behavior compared to their experience with face-to-face communication.	Many different adaptations to communication behavior were identified – greater processing of messages before they were conveyed to make them more focused, clear, precise, neutral, concrete, concise, persuasive, considerate, and complete. Likert scale 4.6 of 7 indicates agreement that adaptations were made to compensate for not being FTF. 95% of participants reported adaptations made (chi-square $p < .001$ with a large effect size).	A price was paid in time and effort spent to overcome obstacles.
H3. Teams who use a lean, asynchronous electronic communication media for process improvement will have greater success of the team outcome than teams who use face-to-face communication.	Perceived results of adaptations were many improvements in the effectiveness, efficiency, and quality of the team effort over FTF. All four teams successfully completed business process improvement redesigns and either partially or fully implemented them within 6 months.	A price was paid in time and effort that improved quality.

for their team, but were in a crunch time and could not schedule the face time to make meetings happen. Several team members commented that the only way process improvements could have been devised and/or implemented under such difficult conditions was through virtual teams.

The results above cannot be explained by traditional media richness or social presence theories. Results, both in support of

CAT and questioning CAT, are summarized in Table 2, Summary of results. The table is organized according to the three hypotheses based on CAT. Virtual team participants perceived obstacles to communication posed by an asynchronous electronic communication media (AECM) (H1), made adaptations to their communication behavior to overcome those obstacles (H2), and those adaptations yielded a perception of higher

success of business process redesigns than those expected as a result of a similar face-to-face effort (H3).

As one can ascertain from visual inspection, the majority of the evidence lies in the “supports” column. Members of the virtual teams using an asynchronous ECM perceived many obstacles (H1) to natural communication when compared to the face-to-face medium. They perceived less interactivity (immediacy of feedback), lower channel capacity (inability to convey nonverbal cues), and less adaptiveness (personalized messages or individual acknowledgements). Some of these were compensated for by the fact that their written messages were posted and printable.

The quantitative scale responses indicated that, on the average, participants agreed that adaptations were made. Ninety-five percent of the participants reported making adaptations (H2) to their communication behavior in order to overcome the perceived obstacles posed by the asynchronous ECM. They processed their messages before sending them to make them more: focused, clear, precise, neutral, concrete, concise, persuasive, considerate, and complete. They captured language and social cues in writing, requested feedback, reflected more on their own and others’ messages, and printed messages for perusal. Somewhat ironically, most of these “adaptations” were also considered “improvements” over the face-to-face environment.

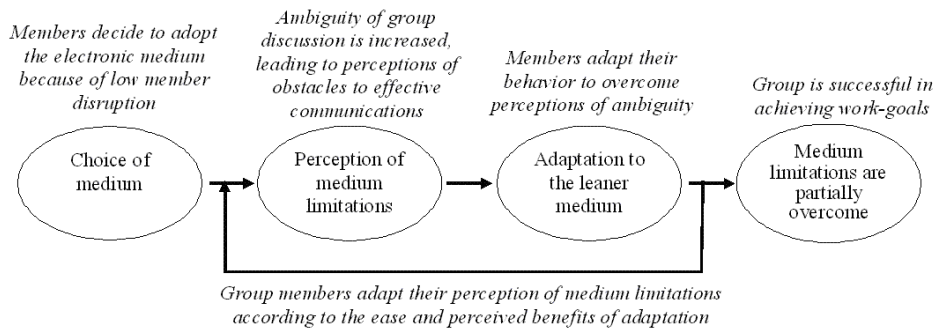
The adaptations made by team members had the effect of making a lean ECM function more richly. The results of the adaptations were improved team effectiveness, efficiency, and quality, as perceived by the team members. They contributed more, were more open to others’ ideas, were more organized, more focused, and

felt that the overall time commitment has been less than if they had communicated face-to-face.

The adaptations, effectiveness, and efficiencies all contributed to a perception of greater quality, which in turn is perceived to have affected the success rate of the project. Success (H3) of the team outcome is indicated by all teams either fully or partially implementing their process redesigns within 6 months. This is more than three times a typical success rate for FTF process improvement efforts (Malhotra, 1998), and, if repeated over several projects, could be a considerable accomplishment. The results of this study regarding adaptations that lead to success support results from the process innovation literature, where the factors most integral to success are quality of redesign and management support (Choi & Liker, 1995; Robinson, 1988). DeLuca (2003) reported a perception that management is more likely to support projects in which they have personally been involved (enabled by ability to be a virtual team member), that have effective input from necessary stakeholders, and that save money through efficiency. These results are similar to the aspects of success most frequently mentioned in our study.

One cannot dismiss the many times participants indicated that they had put forth extra effort to compose their messages. It is not clear at what point the extra effort reported to use the AECM would be too much of a burden, or how long participants could continue the effort on an extended project. It is conceivable that participants would at some point avoid a project knowing the effort required. Studies indicate that largely virtual teams might also choose synchronous media for part of the project, especially the final convergence on a redesign (DeLuca & Valacich, 2005); voice mail

Figure 2. An enhanced model of the compensatory adaptation process



to support social cohesion; or media with no written record to discuss political aspects of a project (Gasson & Elrod, 2005).

One must also account for the difference in the Likert scale data obtained largely in advance of the personal interview, which indicated *some* perception of adaptations, and the chi-square data from the interview, indicating *many* adaptations. One explanation may be that, when responding to the Likert statements, perceived *disadvantages* of face-to-face communications (DeLuca & Valacich, 2005; Robert & Dennis, 2005) were weighed against adaptation made to use asynchronous electronic communication media. Another possible explanation is that participants had become so used to making the adaptations that their perception of having made them was altered. We would therefore propose an amended version of CAT illustrated in Figure 2, to be tested in future studies in which virtual team participants amend their perceptions of medium limitations according to their individual experience of the *ease of* and *benefits of* compensating for these limitations.

Limitations

As with any study, the limitations should be identified so that results may be put in perspective. Although the four teams were studied in-depth and all individuals were interviewed, generalizability should be viewed with caution until more studies corroborate the results. Only those results occurring in at least half of the teams were reported. Since the first researcher was closely involved throughout the study, the bias of individual interpretation is present. Bias was reduced through independent analysis and constant comparison between co-coders.

Implications for Researchers

This study contributes to filling the theoretical gap for explanations of the success of virtual teams solving complex problems using lean media. Compensatory adaptation theory (CAT) has shown itself to be a potential alternative to traditional theories that cannot explain the successes of virtual teams performing complex tasks. Like media richness theory and social presence theory, CAT explains how asynchronous ECM are unnatural, and how they

pose obstacles to effective communication. Unlike the traditional theories, CAT also explains how adaptations to communication behavior more or less compensate for the obstacles to communication posed by the media, resulting in a lean medium functioning more richly and producing more successful team outcomes. More research needs to be done to test the theory in different environments, perceived advantages of and adaptations to a variety of media, and to examine the longer-term implications of making adaptations.

This study also suggests an enhancement to CAT, that successful use of lean media produces a reduced perception of obstacles. Also, a miniscale with reasonable reliability was generated to measure the strength of the perception of compensatory adaptations and may be useful in future studies. An operationalization of compensatory adaptations made in response to lack of interactivity, channel capacity, and adaptiveness is derived from the data. Communications were adapted to be more focused, clear, precise, neutral, concrete, concise, persuasive, considerate, and complete.

Implications for Practitioners

Practitioners are already motivated to attempt virtual teams because of the difficulties of convening face-to-face teams in a global 24/7 enterprise, and the availability of low-cost Internet-based asynchronous electronic communication media. Yet many have been reluctant to conduct virtual teams for complex tasks, fearing failure. The success of the teams in the natural environment of this study in a natural environment provides encouragement to attempt virtual teams for the business process improvement task, given the structures employed here. This study

shows that the yield can be effectiveness, efficiency, quality, and success. Practitioners are also cautioned that the price paid in time and effort to make the adaptations listed above may take its toll over time. Yet, for now, the outlook for extending the variety of complex tasks tackled by virtual teams is optimistic.

Conclusions

All four teams in an organization needed to address business process difficulties for their team, but were in a “crunch” time, making a series of face-to-face meetings nearly impossible. Instead of face-to-face communication, the teams used simple asynchronous electronic communication media. Four teams successfully redesigned a business process, and successfully implemented all or part of their redesign within 6 months.

Members of the virtual teams in the study were interviewed and reported making numerous adaptations to their communication behavior in order to be effective using media of low richness. They reported making an effort to change their communications in order to make them more focused, clear, precise, neutral, concrete, concise, persuasive, considerate, and complete. They captured language and social cues and requested feedback in writing. Team members reflected on and reformulated messages and printed them for perusal. These behaviors made the lean media appear to function more richly, and led to better perceived quality. These results may be transferable to similar contexts (Lee & Baskerville, 2003; Walsham, 1995).

The success of teams accomplishing a complex task with lean media is contraindicated by traditional media richness theory or social presence theory. Traditional theories posit that successful completion of

complex tasks like process improvement requires rich media like face-to-face. This study contributes to filling a gap in information systems research by supporting a new theory, compensatory adaptation theory, which explains the success of virtual teams using lean media. We also contribute operationalization of a key construct, compensatory adaptation.

The compensatory adaptation theory may explain how virtual team members adapt their communication behavior to compensate for, or even overcompensate for, the perceived obstacles to communication posed by the use of the lean media. Consideration of both the need for e-collaboration and the price of making adaptations in order to use e-collaboration opens the door to the rewards of conducting virtual teams for increasingly complex tasks.

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