

MEDIA, TASKS, AND COMMUNICATION PROCESSES: A THEORY OF MEDIA SYNCHRONICITY¹

By: Alan R. Dennis
Kelley School of Business
Indiana University
Bloomington, IN 47405-1701
U.S.A.
ardennis@indiana.edu

Robert M. Fuller
College of Business
University of Tennessee
Knoxville, TN 37996
U.S.A.
rmfuller@utk.edu

Joseph S. Valacich
College of Business
Washington State University
Pullman, WA 99164-4743
U.S.A.
jsv@wsu.edu

composed of two primary processes: conveyance and convergence. The familiarity of individuals with the tasks they are performing and with their coworkers will also affect the relative amounts of these two processes. Media synchronicity theory proposes that for conveyance processes, use of media supporting lower synchronicity should result in better communication performance. For convergence processes, use of media supporting higher synchronicity should result in better communication performance. We identify five capabilities of media (symbol sets, parallelism, transmission velocity, rehearsability, and reprocessability) that influence the development of synchronicity and thus the successful performance of conveyance and convergence communication processes. The successful completion of most tasks involving more than one individual requires both conveyance and convergence processes, thus communication performance will be improved when individuals use a variety of media to perform a task, rather than just one medium.

Keywords: Media theory, media capabilities, media richness, collaboration technology, communication, conveyance, convergence

Abstract

This paper expands, refines, and explicates media synchronicity theory, originally proposed in a conference proceeding in 1999 (Dennis and Valacich 1999). Media synchronicity theory (MST) focuses on the ability of media to support synchronicity, a shared pattern of coordinated behavior among individuals as they work together. We expand on the original propositions of MST to argue that communication is

Introduction

One of the most widely used media theories is media richness theory (MRT), which argues that task performance will be improved when task information needs are matched to a medium's information richness (later called just *media richness*). Media capable of sending "rich" information (e.g., face-to-face meetings) are better suited to equivocal tasks (where there are multiple interpretations for information) and less rich media (e.g., computer-mediated communication) are best suited to tasks with a lack of information.

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MRT was developed to theorize which media should prove *most effective*, not to theorize how managers *choose* media (Daft and Lengel 1986; Dennis and Kinney 1998). However, empirical tests of MRT for “new media” such as computer-mediated communication have not been convincing (Burke and Chidambaram 1999; Carnevale et al. 1981; Dennis and Kinney 1998; El-Shinnawy and Markus 1992; Kinney and Watson 1992; Lee 1994; Markus 1994; Mennecke et al. 2000; Ngwenyama and Lee 1997; Rice and Shook 1990; Trevino et al. 1990; Valacich et al. 1993; Vickery et al. 2004). We have two options to improve on our understanding of media and performance: (1) refine MRT to address the weak findings with new media (e.g., Carlson and Zmud 1999; Sheer and Chen 2004), or (2) formulate a new theory that addresses the capabilities of new media (e.g., McGrath and Hollingshead 1993, 1994; Rana et al. 1997).

In this paper, we take the second approach, providing an expansion and new explication of media synchronicity theory (MST) (Dennis and Valacich 1999). Following from the fit-appropriation model (Dennis et al. 2001), we argue that the fit of media capabilities to the *communication* needs of the task influence the appropriation and use of media, which in turn influence communication performance.

Key Differences from Prior Media Theories

We believe that the version of MST as presented in this paper has six key differences from prior media theories. First, we reconceptualize task as *the set of communication processes* needed to generate shared understanding. We argue that regardless of overall work objectives, communication (the development of shared understanding) is composed of two primary processes, conveyance of information and convergence on meaning (see Miranda and Saunders 2003). All work requiring more than one individual is composed of different combinations of these two fundamental processes. This reconceptualization facilitates a more precise examination of the interaction of media capabilities and what people do when communicating, as opposed to the use of larger, more monolithic and potentially ill-fitting task categories.

Second, we argue that these communication processes (conveyance and convergence) have both interpersonal aspects and cognitive aspects (Miranda and Saunders 2003; Robert and Dennis 2005; Zigurs and Buckland 1998). In order to perform conveyance or convergence, an individual must engage in two individual processes: *information transmission* (preparing information for transmission, transmitting it through a medium, and receiving information from a medium) and *information processing* (understanding the meaning of information and integrating it into a mental model). The

focus is *among* individuals for information transmission and *within* individuals for information processing. Conveyance and convergence require both information transmission and information processing, but often in different proportions, as we will argue later.

Third, the theory identifies physical media capabilities that, through their appropriation and use, impact how individuals can *transmit* and *process* a message. While many media theories identify media characteristics, many of these characteristics are actually socially derived characteristics (e.g., immediacy of feedback, personalization, social presence), whose salience is influenced by prior experiences and context of use. Our identification of physical media capabilities provide two important differences: first, they are specific enough for identification and testing, and second, as media *capabilities*, they connote a range of potential impacts on communication performance, dependent on their appropriation. We identify five media capabilities that influence information transmission and/or processing.

Fourth, in this age of digital convergence, specific media tools acquire new capabilities rapidly so that it is no longer appropriate to refer to a specific digital medium but rather the set of features that medium offers. For example, instant messenger has been a predominately text medium, yet many new IM tools now provide audio, video, image sharing, and even application sharing, making them media that are quite different from traditional text-only IM chat.

Fifth, we argue that the *manner* in which individuals use media influences their communication performance (the development of shared understanding). Generally speaking, convergence processes benefit from the use of media that facilitate *synchronicity*, the ability to support individuals working together at the same time with a shared pattern of coordinated behavior, while conveyance processes have a lesser need for synchronicity.

Finally, we do not argue that any one medium is inherently better than another. We argue that most tasks are composed of a series of communication processes that need different media capabilities. For all but the simplest tasks, communication performance will be enhanced when different media are used at different times; it is usually best to use several media either simultaneously (e.g., face-to-face communication accompanied by documents; telephone conferencing with synchronous electronic conferencing) or in succession (e.g., conveying information via e-mail first, followed by converging over the phone). Additionally, we propose that as the familiarity with the task, individuals, and communication media increases, the need for media supporting high synchronicity is reduced.

Key Differences from the Original Media Synchronicity Theory

The original version of MST was first proposed in a paper presented at the 32nd Hawaii International Conference on System Sciences (Dennis and Valacich, 1999). As a result of the consideration of additional work in this area by us and others, the current conceptions and definitions presented in this paper provide a clearer theoretical conception of media, the communication tasks performed via media, and their relationship to communication performance. This version has enhanced the theoretical basis of that original paper, revised the original propositions, and added new propositions.

The MST described in this paper expands on the original by providing a stronger theoretical basis for the constructs and relationships that make up the theory. For example, Shannon and Weaver's (1949) theory on communication provides the foundation with which we identify five capabilities of media, adding transmission velocity in lieu of immediacy of feedback (which we now identify as an outcome of interaction). Furthermore, we now provide a more robust theoretical basis of how these media capabilities interact with the more fundamental communication processes used to develop shared understanding by influencing information transmission and information processing and how this relates to the ability of media to support synchronicity. Finally, we apply the time, interaction, and performance (TIP) theory (McGrath 1991) to understand how communication process requirements change as relationships develop, suggesting changes in the need for different media capabilities over time.

As a result, we identify new propositions that describe the relationship between media capabilities and synchronicity and how this synchronicity relates to task communication requirements for communication performance. This results in a better explicated and precise set of constructs and relationships that enhance the application of MST in future research on media and communication performance. We believe that MST is now better focused and defined to make predictions about communication performance, yet is also broad enough to allow for the examination of a cadre of media types and capabilities in various contexts of use.

Prior Media Theories

Theories about communication and media are abundant (Fulk and Boyd 1991; Putnam et al. 1996). Perhaps the most influential theory, at least for the "new media" (Rice 1992), is media richness theory (Daft and Lengel 1986). MRT initially

did not consider new media, but they have been retroactively fit into the theory's framework (Dennis and Kinney 1998). MRT is similar to other media theories of its era (e.g., social presence theory, Short et al. 1976), in arguing that media differ in their ability to transmit certain information or cues (cf. cues-filtered out theory, Sproull and Kiesler 1991). Specifically, MRT argues that media differ in richness ("the ability of information to change understanding within a time interval," Daft and Lengel 1986, p. 560). Face-to-face communication is the richest, while media capable of sending fewer cues (e.g., no vocal inflections) or providing slower feedback (e.g., written communication) are "leaner." Communication and task performance will improve when managers use richer media for equivocal tasks (where there are multiple and possibly conflicting interpretations of information) and leaner media for non-equivocal tasks (Daft and Lengel 1986; Daft et al. 1987). Most studies of MRT have used it to predict media *choice*, not *performance*, which is what the theory actually addresses (Dennis and Kinney 1998). Typically, researchers have asked managers to *choose* which medium they would use to send a set of hypothetical messages, looking to see if the managers' espoused choices fit the propositions of the theory (e.g., Daft et al. 1987; El-Shinnawy and Markus 1992; Trevino et al. 1990). Few studies, however, have examined communication or task performance (e.g., Dennis and Kinney 1998; Kanawattanachai and Yoo 2007; Rice 1992; Yoo and Alavi 2001).

Because MRT did not accurately reflect managers' media choices, Trevino et al. (1987) proposed a symbolic interaction extension to it by arguing that some media carry symbolic meaning above and beyond the content of the message (e.g., written media are more formal). This symbolic meaning "deflect[s] media choice behavior away from the rational matching of task ambiguity and media richness" (Fulk and Boyd 1991, p. 410) so that media choice is based on the perceptions that users hold about its symbolic meaning as well as its actual characteristics.

Social information processing theory (later called social influence theory) argues that media richness is not an objective, physical, property of a medium (Fulk, Schmitz, and Steinfield 1990; Fulk et al. 1987). Instead, media richness is in part socially constructed and different individuals may hold different perceptions of richness (see Lee 1994). This theory focuses on media choice, not communication performance, but researchers have concluded that factors beyond media richness also affect other outcomes (see Fulk and Boyd 1991; Rice 1992).

Walther (1992) argues that rather than looking at media characteristics, we need to also consider the people using the

media. He argues that over the long run, communication transcends media (i.e., the medium is *not* the message). Communicators are motivated by the same drivers regardless of media used, so deep personal relationships can be developed through very lean media, although it may take much longer. He concludes that “over time, computer mediation should have very limited effects on relational communication” (Walther 1992, p. 80), other than to slow it.

In a different perspective on media and communication performance, DeSanctis and Poole’s (1994) adaptive structuration theory argues that it is not the objective physical characteristics of the medium that matter, but rather how those characteristics are appropriated and used. Communication participants may appropriate and use media characteristics as intended by the designers, or they may appropriate and use them in ways not intended or even expected. The physical characteristics that are used are influenced by the participants’ existing social structures and how the media’s physical structures are understood. The physical structures that are appropriated in turn influence the social structures that participants use, which in turn may influence future appropriation and use.

Channel expansion theory builds on MRT (Carlson and Zmud 1999), arguing that the perceived richness of a medium depends not only on its characteristics, but also on the users’ experience using it, and with each other, and perhaps also with the task and the organizational context in which the use occurs. Thus, while the physical characteristics of a medium may be fixed, users’ perceptions of a medium depend upon their own characteristics and experiences, which may change over time. This theory has been applied primarily on media choice research.

Yoo and Alavi (2001) argue—and provide empirical evidence—that social presence, the extent to which the media enables the perception of others’ presence (Short et al. 1976), is affected not only by objective characteristics of the medium (e.g., cues), but also by the nature of the individuals using it. They found that in established groups, whose members had worked together for several weeks, the level of group cohesion (i.e., members’ attraction to the group) was directly related to the perception of the social presence provided by a medium. Members of highly cohesive groups reported higher social presence for both audio-only conferencing and desktop videoconferencing with application sharing, but social presence had no impact on task performance.

More recently, Kock’s (2004) psychobiological model, based on Darwin’s theory of evolution, argues that humans have evolved to favor face-to-face communication, and the lower

the “naturalness” of a medium (i.e., colocation, synchronous communication, facial cues, body language, and especially spoken words), the greater the cognitive effort required to use it. As individuals appropriate and use a medium, they can adapt to it, so cognitive effort decreases with use (e.g., DeLuca et al. 2006). Because such adaptation is learned, the cognitive effort required to use a nonnatural medium depends upon the extent to which the communicating individuals hold similar views about the medium and how to use it. Based on this theory, improved communication performance could come about through the learned reduction of cognitive effort required to use the medium that facilitates the interaction for the task.

A major consideration for any media performance theory is the facilitation of interactions necessary for the sharing of information and the development of meaning(s) ascribed to that information. Miranda and Saunders (2003) argue that one key outcome of communication is the development of intersubjective meaning of the information held by the participants: “*meaning derives from interactive interpretation by multiple persons, not simply from the cognition of a single individual*” (p. 88, emphasis in original). In other words, meaning is co-constructed by the communication participants (Boje 1991; Eisenberg 1990; Weick 1979). Understanding is not just transmitted from one participant to another, but evolves from the interactions among participants. Understanding of meaning is not possible without this interaction. For media theories, this means that the impact of media on communication performance will derive from its ability to facilitate the interactions necessary to support meaning development by communication participants.

Prior theories have approached communication from many different vantage points and often have made different—sometimes conflicting—fundamental assumptions about the nature of communication and media. Our approach essentially follows what Putnam et al. (1996) call the “conduit metaphor,” in which we treat the communication medium as a conduit among participants. We do, however, move beyond the pure transmission of information through this conduit to understand how the information is processed by the receiver. The conduit may be best thought of as a “reagent” (Lee 1994, p. 154), in that the information received can trigger extensive information processing as the receiver “elaborates” (Petty and Cacioppo 1986) on a message to understand it, integrate it into his or her cognitive schema, and possibly draw implications far beyond the message itself (Lee 1994; Petty and Cacioppo 1986). The medium enables the transfer of information, from which information processing creates meaning (Miranda and Saunders 2003; Sitkin et al. 1992).

We begin with five fundamental assumptions, which represent boundary conditions to our theory. First, we start with the premise that the purpose of communication is to develop shared understanding (Miranda and Saunders 2003; Rogers 1986; Te'eni 2001). We explicitly do not address situations in which the intent of some participants is to deceive other participants, although some parts of our theory may be useful in this research area (e.g., Carlson and George 2004).

Second, we believe that such shared understanding *can* be co-constructed by the communication participants (Boje 1991; Eisenberg 1990; Miranda and Sanders 2003; Weick 1979), but that co-construction does not *always* occur (Sitkin et al. 1992). With co-construction, communication participants jointly and interactively work together to create meaning and shared understanding so that the communication changes every participant's understanding of the information and its meaning. We believe that it is possible but not necessary for communication to involve co-construction; sometimes communication changes everyone's understanding of meaning, other times no one's understanding has changed.

Third, the spirit by which shared understanding is developed is what Habermas terms *ideal speech*:

to ensure that (a) all voices in any way relevant can get a hearing, and that (b) the best arguments we have in our present state of knowledge are brought to bear, and that (c) disagreement or agreement on the part of the participants follows only from the force of the better argument and no other force. (Habermas and Nielsen 1990, p. 104)

We do not specifically address situations where some participants desire to manipulate or control how other participants interact so that the shared understanding that is developed does not reflect the information and opinions of all participants, however, parts of this theory may be useful in this research area as well.

Fourth, a medium has objective physical characteristics (e.g., it can or cannot transmit voice, it can or cannot store a copy of a message) that we prefer to call *media capabilities*. These capabilities may or may not be well understood by communication participants, and thus may or may not be appropriated and used as expected (DeSanctis and Poole 1994). The media capabilities that are used can induce the creation of subjective, socially developed characteristics which may be perceived differently by different users, or perceived differently by the same user over time (Carlson and Zmud 1999; Fulk et al. 1990; Walther 1992). Our theory begins with a set of physical media capabilities that can induce the creation of a

socially developed characteristic that we term media synchronicity, which may differ from person to person and over time.

Finally, most prior media theories have focused on media choice. In contrast, our theory is a theory of *communication performance, not media choice*. We do not address the myriad of factors that influence how people choose which medium or media to use, although the desire to achieve shared understanding is likely one factor that influences media choice.

Rethinking Task

"Task" has been a key element in the development and testing of media theories (Daft and Lengel 1986; Dennis and Kinney 1998; Mennecke et al. 2000; Rice 1992; Suh 1999; Zigurs and Buckland 1998). However, studies comparing task performance between individuals working on different tasks with different media have not convincingly shown that a better match of media to the task will yield better task performance (Dennis and Kinney 1998; Hollingshead et al. 1993; Mennecke et al. 2000; Rice 1992; Straus 1997; Straus and McGrath 1994; Suh 1999). Task performance differences attributed to the fit between media and task have not been consistent.

In contrast, our primary thesis is that *communication* performance comes from the matching of media *capabilities* to the *communication processes* required to accomplish a task, not to the overall task itself. We contend that regardless of the type of task (e.g., equivocal or uncertain, Daft and Lengel 1986; negotiation or decision-making, McGrath 1984), individuals working together perform a similar set of more fundamental micro-level communication processes. This is not to say that task is unimportant, but that it is at the wrong level of analysis; it is too broad.

We believe that *task* is best thought of in terms of the fundamental communication processes that must be performed. This is analogous to the concept of *steps*, which are the underlying acts required to accomplish a task (McGrath 1991). To better understand task outcomes, we must understand how individuals perform these underlying steps in terms of which steps they choose to perform, in what order, and when. Every task involving more than one person requires a mix of different communication processes to perform these steps. To understand how media can influence communication performance, it is necessary to more carefully examine underlying communication processes (Fulk and Boyd 1991; Huang and Wei 2000), which include both the transmission of information and the individual cognitive processes to make

sense of the information (Miranda and Saunders 2003; Robert and Dennis 2005; Zigurs and Buckland 1998).

Communication has been defined as “a process in which participants create and share information with one another in order to reach a mutual understanding” (Rogers 1986, p. 199). Sharing information is inherently an exchange process, in which developing meaning requires a dissemination of information (*information transmission*) and individual processing of that information (*information processing*). Developing shared meaning requires that individuals not only understand the information they have, but also understand how others interpret it. Thus an important outcome of successful communication is the development of shared understanding about the information and the meaning that each participant attaches to it (Daft and Lengel 1986; Miranda and Saunders 2003; Rogers 1986; Te’eni 2001).

Based on the need to both transmit and process information, we identify two fundamental communication processes relevant to all tasks: conveyance and convergence. *Conveyance processes* are the transmission of a diversity of new information—as much new, relevant information as needed—to enable the receiver to *create* and *revise* a mental model of the situation. Individuals participating in conveyance processes engage in substantial information processing activities so that a potentially large, diverse set of information can be exchanged in a variety of information formats. Individuals participating in conveyance processes will often require time to perform information processing—the cognitive processes necessary to analyze the information, make sense of it, and build their mental models.

Convergence processes are the discussion of preprocessed information about each individual’s *interpretation* of a situation, not the raw information itself. The objective is to agree on the meaning of the information, which requires individuals to reach a common understanding *and* to mutually agree that they have achieved this understanding (or to agree that it is not possible) (Lind and Zmud 1991). Convergence typically needs rapid, back and forth information transmission of small quantities of preprocessed information. Convergence can require less information processing than conveyance when it focuses on the verification of and/or modest adjustments to existing mental models. If individuals agree on the interpretation of some or many elements of the situation, then those elements do not need much information processing; the scope of the information space is reduced and thus individuals need to devote less information processing to those elements than they did during the initial consideration of the situation when the information was first conveyed. In this case, information processing during convergence is reduced, as it focuses on a

smaller set of information than the entire information space. However, when individuals have large differences in their individual understanding, convergence may require as much or more cognitive processing as conveyance.

These two fundamental communication processes are consistent with research on understanding development. Weick (1985) argues that individual sensemaking involves first making observations and gathering information in a variety of different formats (e.g., photos, transcripts, numbers) from a variety of sources (e.g., individuals, organizations, databases). This mass of information is subjected to slow retrospective examination and careful reasoning to induce patterns and generate conclusions. Individuals draw on their prior knowledge and mental models to ascribe meaning to the information so this deliberation requires time as the mass of information is reduced to an edited, simplified comprehension (Ahituv et al. 1998; Robert and Dennis 2005). We use the term conveyance to refer to this gathering and dissemination of information combined with individual information processing to generate *individual* understanding.

Shared sensemaking further requires individuals to examine how others understand information, and to negotiate on a mutually agreed-upon meaning (Weick 1985). This requires the sharing of each individual’s “distilled” understanding, which is generally smaller than the original set of information as it represents a higher level framework or abstraction of the original information (Carley 1989; Weick and Meader 1993). Establishing shared understanding (which we call convergence) is the assessment of the overlap and similarity in conclusions drawn by others. This requires rapid transmission but not as deep analysis of the distilled information because the information has already been processed (Carley 1989; Minsky 1986; Petty and Cacioppo 1986).

In summary, there are two key implications from rethinking task. First, most tasks (e.g., decision-making, negotiation) will require *both* conveyance and convergence processes, regardless of the task’s type or level of equivocality or uncertainty, although the proportion and duration of these fundamental communication processes will vary from task to task and from individual to individual. Without adequate conveyance of information, individuals will reach incorrect conclusions. Without adequate convergence on meaning, individuals cannot move forward to other activities as they will lack a shared understanding. Therefore, to understand communication performance, it is necessary to look at the underlying communication processes (conveyance and convergence) as they are facilitated or constrained by the media used.

Second, these communication processes involve (in some degree) both the individual *transmission* of information and

the individual *processing* of information (Miranda and Saunders 2003; Robert and Dennis 2005; Zigurs and Buckland 1998); both activities are essential to the successful development of shared understanding. To understand how people use media and how this use affects successful and unsuccessful communication, we must consider both the need to transmit information among people as well as the individual cognition needed to process and understand that information.

As a result, we conclude that prior task conceptualizations are too broad to make accurate prescriptions about the “best” media to use for improving task performance. By redefining task as the underlying conveyance and convergence processes, we can more precisely understand how media capabilities may enhance or impair communication performance (the development of shared understanding) by impacting information transmission and information processing.

Media Synchronicity Theory

We argue that the fit between the information transmission and information processing needs of the communication processes and the information transmission and information processing capabilities of media will influence the appropriation or use of the media and ultimately communication performance (see Figure 1). We contend that convergence processes have a greater need for rapid information transmission and lesser needs for information processing² while the reverse is true for conveyance processes. Convergence processes benefit from *synchronicity* (which we define below) while conveyance processes do not. We contend that certain media capabilities influence the way individuals can transmit and process information and the degree they can work—their level of synchronicity. Thus there is a fit between communication processes and media capabilities that facilitates faithful appropriation, leading to better outcomes.³

As shown in Figure 1, it is not solely the media or their capabilities that directly influence communication performance, but also the way in which they are appropriated and used (Dennis et al. 2001; DeSanctis and Poole 1994). In this paper, we focus primarily on the fit between the communication processes and the media, not on the appropriation

behaviors, as they may be influenced by the fit of the medium to the task, training, familiarity, norms, past experiences, and so on (Carlson and Zmud 1999; Dennis et al. 2001; DeSanctis and Poole 1994). We will return to appropriation later in the paper, but at this point, we will assume that appropriation and use is faithful to the fit of the media to the communication process (DeSanctis and Poole 1994).

Media Synchronicity

Synchronous or asynchronous communication has long been recognized as an important factor affecting interpersonal communication and team work (Burke and Chidambaram 1999; Walther 1996). Some media are used synchronously, so that all communication participants are communicating at the same time (e.g., face-to-face communication, video conference, telephone conference). Others are typically used asynchronously so that participants do not work together at the same time (e.g., fax, voice mail). Others can be used either synchronously or asynchronously depending upon how they are appropriated (e.g., discussion forums, electronic mail).

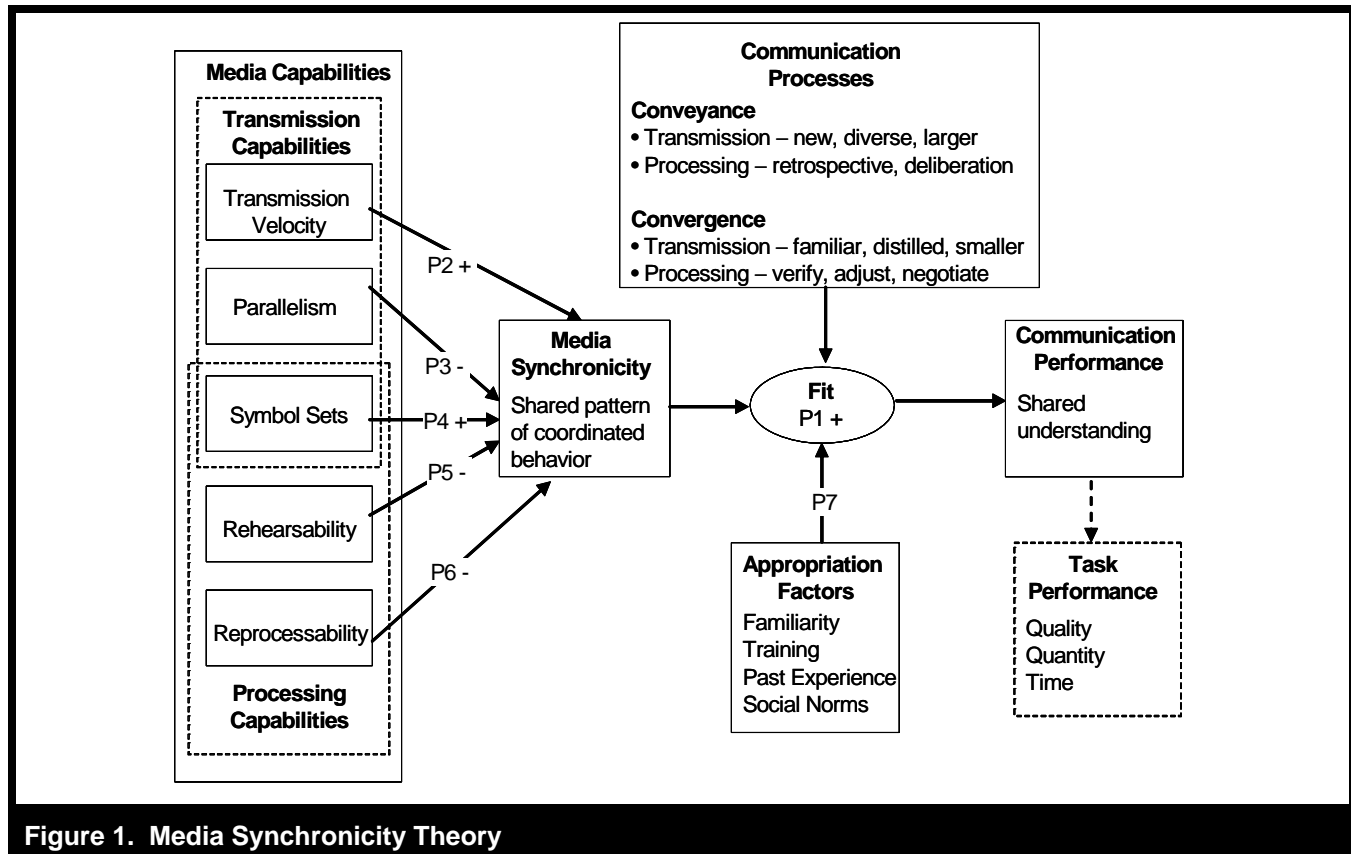
Synchronicity is a state in which actions move at the same rate and exactly together (Random House 1987). Synchronicity exists among individuals when they exhibit a shared pattern of coordinated synchronous behavior with a common focus (Harrison et al. 2003, McGrath and Kelly 1986). Research shows that when individuals use electronic media synchronously, they often attend to information asynchronously (Miranda and Saunders 2003). Thus synchronous use of media does not always imply true *synchronicity*—a state in which individuals are working together at the same time with a common focus. Synchronous communication is necessary but not sufficient for synchronicity; although individuals may work synchronously, they may not achieve synchronicity. We define *media synchronicity* as the extent to which the capabilities of a communication medium enable individuals to achieve synchronicity.

Media Synchronicity and Communication Processes

The differences between conveyance and convergence processes indicate that they have different requirements for information transmission, information processing, and, consequently, synchronicity. Conveyance focuses on the transmission of large amounts of raw information and subsequent retrospective analysis, suggesting that individuals will have less of a need to transmit and process information at the same time (Robert and Dennis 2005). Alternatively, convergence

²This is not meant to imply that information processing is not important for convergence, but that the focus is on information transmission. The reverse is also true for conveyance.

³It is critical to understand that we are *not* matching *task* to media, but rather the lower level construct of communication processes to media.



focuses on the transmission of higher-level abstractions of information and negotiations of these abstractions to existing mental models, suggesting that individuals will have a greater need to quickly transmit and process smaller volumes of information to develop a shared understanding (see Table 1).

When people work together at the same time with a shared pattern of coordinated behavior (i.e., high synchronicity) there is a greater level of interaction and shared focus between message senders and the recipients than when they do not (Ballard and Seibold 2004). High synchronicity is associated with reduced cognitive effort to encode and decode messages, yielding faster message transmissions, so a message can be assessed and modified quickly, even during transmission itself (Clark 1992; Jacobs 1974; Kock 2004; Zmud et al. 1990). High synchronicity can also provide individuals with the ability to receive immediate feedback, enabling the message sender to use communication patterns such as “installments,” which enable the sender to break up a message and seek the recipient’s feedback after each installment is sent (Clark and Wilkes-Gibbs 1986), or offer trial references to test the recipient’s agreement and understanding (Clark and Brennan 1991).

Lower synchronicity implies that individuals can take more time between messages, allowing them more time for information processing to analyze the content of a message or to develop meaning across messages (Robert and Dennis 2005). Likewise, lower synchronicity implies that individuals will have the opportunity to craft messages, taking into consideration other issues such as the context in which the receiver will receive the message (Kock 1998). Lower synchronicity is derived from a decreased level of interaction between sender and the recipient.

We propose that for communication performance on convergence processes, higher levels of media synchronicity will be beneficial to support the interactive give-and-take required for sensemaking strategies, leading to more efficient convergence. Convergence requires less deliberation on new information, so in situations where individuals have shared mental models, encoding and decoding familiar information should be faster (Minsky 1986). Since convergence involves a simpler contextualization of information, media capable of supporting higher levels of synchronicity can better provide the ability to coordinate and verify understanding (Graetz et al. 1998; Rogers 1986). Because the goal is to understand

Table 1. Communication Process Characteristics

Communication Process	Information Transmission Characteristics	Information Processing Characteristics	Media Synchronicity Required
Conveyance	Higher Quality Various Formats Multiple Sources	Retrospective Slower	Lower
Convergence	Lower Quality Specific Format Specific Sources Faster	Verification Adjustment Negotiation Faster	Higher

other's *interpretations* of information, *not* the information itself, the ability of the medium to provide synchronicity is important for convergence. Alternatively, using media low in synchronicity can negatively impact convergence processes by increasing delays that impede the rapid development of shared understanding.

For conveyance processes, media lower in synchronicity will lead to better communication performance. To transmit information and enable the analysis typical of conveyance, individuals do not need to work together or at the same time. If the message is complex, with large amounts of information or high diversity of information (Campbell 1988), individuals will require more time to assess and deliberate on the information. Media can influence the way in which individuals use them (Dennis and Reinicke 2004), so that media that support higher levels of synchronicity can generate expectations of rapid interaction which can interfere with deliberation processes. Using media with higher synchronicity for conveyance processes (which require deliberation) may impair development of understanding because individuals will not have the time required to fully process the information (Robert and Dennis 2005). This may cause a greater cognitive load on the individual (Te'eni 2001) and encourage premature action (Weick and Meader 1993). Therefore,

P1: Communication performance will depend on the fit between a medium's synchronicity and the fundamental communication processes being performed.

- (a) For communication processes in which convergence on meaning is the goal, use of higher synchronicity media will lead to better communication performance.
- (b) For communication processes in which the conveyance of information is the goal, use of lower synchronicity media will lead to better communication performance.

Media Capabilities

We define media capabilities as the *potential* structures provided by a medium which influence the manner in which individuals can transmit and process information (see also Rice 1987; Rice and Steinfield 1994). Depending on the configuration of media capabilities, media will vary in their ability to support information transmission and information processing which ultimately determines their capability to support synchronicity.

To help identify media capabilities that may influence information transmission and processing, we turn to one of the oldest and most pervasive theories of communication as proposed by Shannon and Weaver (1949).⁴ The theory states that the transmission of a message begins with a *source* (the message sender) who creates a *message* for transmission. The source uses a *transmitter* (software and/or hardware) to encode or translate the message into a signal (e.g., text, voice, and video) that is sent over a communication *channel* (medium). The channel carries the signal to a *receiver* (software and/or hardware) which is used by the *destination* (recipient) to decode or convert the signal back into the message. (See Figure 2.) In this depiction of a communication system, encoding and decoding processes are important as they represent the processing required by the source and destination to make use of the medium to transmit and receive messages. These processes can impact the relative ease that individuals will have in using the medium and making sense of the messages that come through it.

⁴Although it has been criticized for its linear focus (e.g., Cherry 1978; Rapoport 1956) and other theories have attempted to improve it (e.g., Berlo 1960), the Shannon and Weaver theory has endured for over 50 years as a framework that identifies the components involved in any communication process.

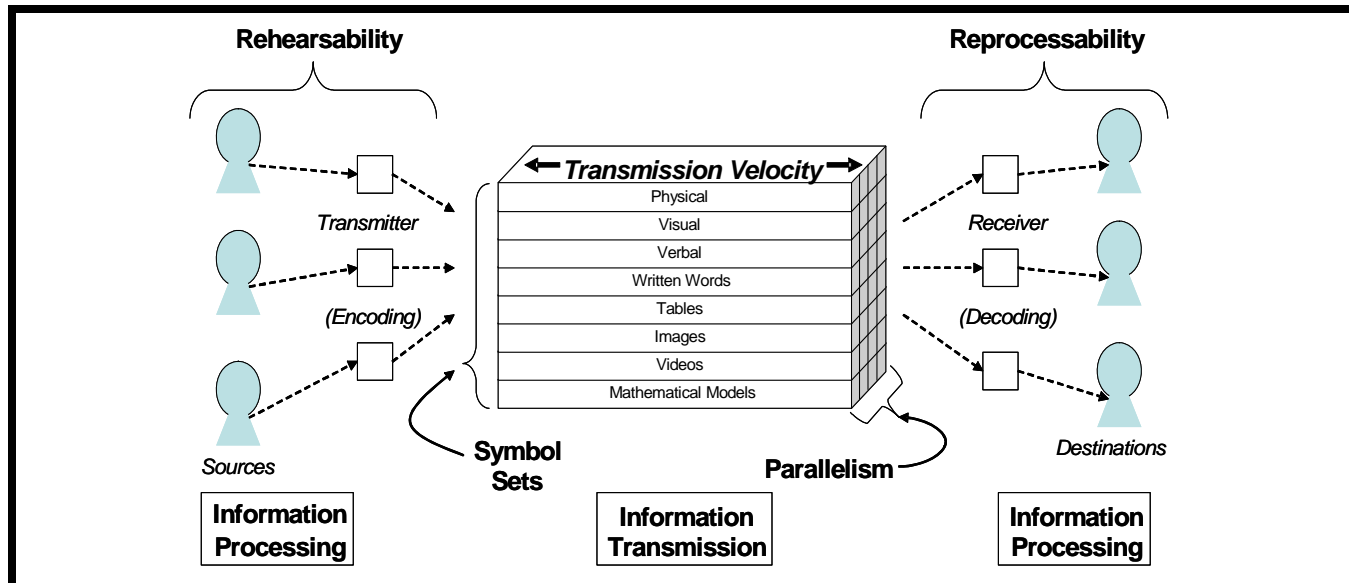


Figure 2. Communication System and Media Capabilities

Media will vary in their capability to support the transmission and subsequent processing of the information contained in a message. Although there are many media capabilities that could plausibly influence communication performance, our goal is to select a relevant set of capabilities that may be used to assess a medium's ability to support information transmission and processing, and subsequently synchronicity. Shannon and Weaver's theory, which is engineering focused, identifies three capabilities that impact the ability of a channel to transmit information: the capacity of the channel (in bits per second), the number of frequencies that can be simultaneously used in the channel, and the types of symbols that can be sent. They also identify that many of the inefficiencies in communication come from the processes of encoding and decoding messages sent in the channel, which we view as relevant to information processing.

Based on Shannon and Weaver's theory, we believe that three primary media capabilities are important in deriving a medium's ability to support information transmission: transmission velocity (Shannon and Weaver's channel capacity), parallelism (analogous to Shannon and Weaver's number of frequencies), and symbol sets⁵ (Shannon and Weaver's

symbol types). Two media capabilities build on Shannon and Weaver's encoding and decoding processes and are important for information processing: rehearsability (encoding) and reprocessability (decoding). While these two capabilities do not necessarily impact information transmission, we include them because they affect individuals' information processing of messages sent over the medium. In the sections below, we assume that media provide the same capabilities to all users (e.g., symbol variety), although this is not always the case; for example, e-mail clients have different capabilities so that a sender may have the ability to include audio-video attachments that a receiver, using a different client, may not be able to access.

Transmission Velocity

Transmission velocity, derived from Shannon and Weaver's capacity concept, is the speed at which a medium can deliver a message to intended recipients. While not expressly identified in prior theories of media, transmission velocity is generally alluded to in terms of *immediate* or *rapid* (as in feedback, Burgoon et al. 1999-2000; Daft and Lengel 1986) and *interactivity* (Te'eni 2001; Zack 1994).

Media that are high in transmission velocity allow messages to reach the recipients as soon as they are sent. Therefore, messages spend less time in transmission. Faster transmission velocity also allows a message to be responded to faster, meaning that the communication can approach continuous

⁵While the symbol set is associated here with information transmission (e.g., the speed at which certain symbol sets can be transmitted, see Kock 2004), it also has ramifications for information processing (the ease with which one can process information as encoded using certain symbol sets, see Vessey 1991).

exchange with improved coordination and quicker feedback between individuals, resembling conversation (Goffman 1967; Rogers 1986; Schegloff 1987). Higher transmission velocity supports synchronicity as it enables improved behavior coordination and shared focus to exist between individuals working together.⁶ Therefore,

P2: Transmission velocity improves shared focus which will have a positive impact on a medium's capability to support synchronicity.

Parallelism

Parallelism, derived from Shannon and Weaver's number of frequencies, is the number of simultaneous transmissions that can effectively take place, which we depict as the width of the medium in Figure 2 (cf. multiple addressability, Rice 1987; Sproull and Kiesler 1991; Valacich et al. 1993). Parallelism is the extent to which signals from *multiple senders* can be transmitted over the medium simultaneously. In traditional media such as the telephone, fewer transmissions can effectively take place over the medium at the same time, limiting the quantity of information transmitted per time period. In contrast, many of the new media can be structured to enable many concurrent transmissions to occur, increasing the volume of information that can be transmitted in a given time period (Burgoon et al. 1999-2000).

By allowing for multiple simultaneous transmissions, parallelism reduces some of the losses that can occur due to the need to transmit sequentially (Dennis et al. 1997; Gallupe et al. 1992; Nunamaker et al. 1991; Valacich et al. 1992). Therefore, messages can be transmitted when desired, at any moment, without having to wait for the channel to clear or open. Likewise, multiple transmissions can be received simultaneously, reducing the time necessary to receive such transmissions as compared to receiving transmissions serially, or one at a time.

Parallelism impacts the synchronicity of a medium by increasing the number of concurrent transmissions and by supporting multidirectional communication (e.g., simultaneous sending of messages to multiple recipients, simultaneous receipt of messages from multiple senders) (Burgoon et al. 1999-2000; Goffman 1981).⁷ By enabling multi-

directional, multiparty transmissions, parallelism enables multiple simultaneous conversation threads (Herring 1999). One user can start discussion on one topic while at the same time another user starts a discussion on a different topic, and a third user starts a third unrelated topic. These three discussions can become intertwined, so that rather than focusing on one topic at a time, the discussion interleaves messages. Parallelism, therefore, reduces the interactional coherence of the discussion and impairs the ability of the users to develop a shared focus (Erickson et al. 2002; Herring 1999, 2003; Simpson 2005). Thus parallelism acts to reduce synchronicity by reducing the shared focus. Therefore,

P3: Parallelism lowers shared focus which will have a negative impact on a medium's capability to support synchronicity.

Symbol Sets

Symbol sets, derived from Shannon and Weaver's types of symbols, are the number of ways in which a medium allows information to be encoded for communication, which we depict as the height of the medium in Figure 2, and subsumes Daft and Lengel's (1986) multiplicity of cues and language variety (cf. channel capacity, Te'eni 2001).⁸ The essence of communication and language is symbols (Littlejohn 1983; Sitkin et al. 1992). Humans can use a myriad of different types of symbols to communicate (Mead 1934; Rogers 1986; Short et al. 1976). At the most fundamental level, we can communicate in physical ways, from a handshake to a gentle touch on a shoulder of a friend, which can communicate volumes. We can communicate in visual ways by raising a hand, nodding the head, or closing our eyes. We can communicate verbally by speaking. We can also use written or digital symbols, such as words, tables, images, video (moving images), mathematical models, and so on.⁹ Many media allow multiple symbol sets to be transmitted simultaneously (e.g., in a face-to-face conversation, we can speak words using different vocal tones and make physical gestures). Symbol sets may affect the synchronicity supported by a medium in two fundamental ways.

⁶Of course, individuals can choose to use media with high transmission velocity in ways that slow transmission speed, but we began this section with the assumption that media are faithfully appropriated.

⁷Of course, individuals can choose to use media with high parallelism in nonparallel ways by taking turns, but we began this section with the assumption that media are faithfully appropriated.

⁸Several authors also discuss the symbolic meanings that arise from using media (e.g., the difference implied by visiting face-to-face versus making a phone call) (Feldman and March 1981; Sitkin et al. 1992). In this section, we focus only on the symbols a medium can support, not its symbolic meaning.

⁹One might also argue that we can communicate through smell and taste and that these should also be included as symbol sets. We view these as being used infrequently and thus omit them from our discussion in the interest of parsimony, although we acknowledge that they can be viable symbol sets in some circumstances.

First, the time and effort required to encode and to decode a message using a specific symbol set may impose production costs (Clark and Brennan 1991) and processing delay costs (Reinsch and Beswick 1990). These costs can alter the way in which the sender encodes messages and can impede the decoding and processing of these messages by the receiver resulting in inefficient transmission and processing of messages. For example, it may be more efficient to transmit agreement with visual symbols such as a head nod than by typing "I agree with you."

Certain symbol sets can affect overall information transmission and processing efficiencies because of the time it takes to encode and decode using that symbol set. Some symbol sets are fast to encode and decode due to their naturalness (Kock 2004). Other symbol sets are slower to encode; for example, an e-mail message takes longer to encode than a verbal message because it takes more time to type than to speak (Williams 1977). Some symbol sets are slower to decode; for example, a written message is faster to decode than a voice mail because reading is usually faster than listening (Williams 1977). Physical, visual, and verbal symbol sets are fast to encode, facilitating turn-taking and coordination and making interactions faster (Goffman 1967; Williams 1977). Thus media incorporating these symbol sets have greater capability to support synchronicity as compared to media with written or typed symbol sets that are slower to encode (and decode).¹⁰ Therefore,

P4: (a) Media with more natural symbol sets (physical, visual, and verbal) have a greater capability to support synchronicity as compared to media with less natural symbol sets (written or typed).

Second, some information may be more precisely encoded and decoded in one symbol set than another. Physical gestures (e.g., touch), visual gestures (e.g., nods, smiles), and vocal tone can be used to emphasize important points, to show doubt or uncertainty, to indicate acceptance, and to amplify meaning beyond the words themselves far more efficiently and effectively than attempting to express those same meanings in spoken or written words (Williams 1977). Conversely, some written or digital symbol formats (e.g., image and textual) can emphasize the same information in different ways (e.g., spatially or symbolically) such that outcomes differ according to the symbol set used (Jarvenpaa 1989; Vessey 1991). Some symbols sets, while easy to encode, may have detrimental effects for decoding as they may add unintentionally to the message. For example, stating

that everyone should calm down while simultaneously pounding one's fist might impair decoding and information processing due to the inconsistencies in the symbols used. Thus, some symbol sets facilitate precise encoding by allowing the sender more control in the application of the symbols used to encode a message, others may inhibit precise encoding, and others may induce the encoding of unintended messages, especially if the participants are from different cultures.

The inability to transmit certain symbols sets (e.g., physical, visual, and verbal symbols) may have some effect on the development of social perceptions (Daft and Lengel 1986; Williams 1977).¹¹ In general, when physical, visual, and verbal symbols are removed, there is a reduction in social presence (Rice 1993; Short et al. 1976), such that the people with whom one is communicating may become less like real people and more like objects, influencing what and how information is communicated (Postmes et al. 2000; Sproull and Kiesler 1991; Williams 1977). These impacts may be temporary, or apply only to initial encounters, because over the long term, deep personal relationships can develop over media lacking these symbol sets (Walther 1982).

Individuals can more effectively and efficiently encode and decode information when the symbol set matches the needs of the message. Symbol sets can be thought of as similar to a "hygiene factor" in the terminology of Herzberg et al. (1953): there is nothing inherently important or satisfying about a particular symbol set, but if the medium does not provide a particular symbol set when it is needed, then communication will be impaired (Farmer and Hyatt 1994). For example, imagine that you are trying to describe how to perform a physical activity on a Web site. A verbal description alone is likely to be less effective than a visual demonstration and a verbal description or a series of annotated screen shots with a written description. Therefore,

P4: (b) Using a medium with a symbol set better suited to the content of the message will improve information transmission and information processing, and therefore will have a greater capacity to support synchronicity.

¹⁰Of course, asynchronous use of physical, visual, and verbal symbol sets (e.g., voice mail) inhibits synchronicity.

¹¹Although Daft and Lengel (1986) and Short et al. (1976) defined personalness (and social presence) as a characteristic of media, we would portray these as socially derived *outcomes* of communication processes that may be moderated by the media's capability to deliver certain cues in a certain way. For example, as noted by Walther (1992, 1996), individuals can *develop* feelings of social presence through any media; however, the media may constrain the speed at which that development occurs. Similarly, Short et al. also suggest that social presence can be an experiential outcome of media use.

Rehearsability

Rehearsability is the extent to which the media enables the sender to rehearse or fine tune a message during encoding, before sending (cf. editability, Rice 1987). Media that support rehearsability enable the sender to carefully craft a message before transmission to ensure that the intended meaning is expressed precisely, thus improving a recipient's subsequent decoding and information processing. Rehearsability is less important for individuals who have common experiences or shared mental models as they can communicate using expected protocols or with known symbols on a familiar subject (Carlson and Zmud 1999; Kock 2004; Zack 1994). However, for new or complex information (e.g., transmissions among individuals without prior shared knowledge), rehearsability is important because it enables the sender to consider the context and possible interpretations of the message and encode it for more accurate decoding and understanding by the recipient (Cornelius and Boos 2003; Kock 1998).

Rehearsability can create delays in the transmission of messages because senders can take longer to compose messages. This is not specifically an impediment of the transmission velocity of the medium itself; rather it is due to the way in which senders appropriate and use the medium to send messages. This delay in message transmission, particularly if a fast response is expected, may reduce synchronicity as it impairs the development of coordinated behavior and focus. The impact of this delay may be offset if the sender takes extra care to attend to and craft a message to better integrate his or her comments with those of others, but there is nothing inherent in rehearsability that will *necessarily* induce this increased attention. Therefore,

P5: Rehearsability lowers shared focus, which will have a negative impact on a medium's capability to support synchronicity.

Reprocessability

Reprocessability is the extent to which the medium enables a message to be reexamined or processed again, during decoding, either within the context of the communication event or after the event has passed (cf. Rice 1987; externally recorded memory, Sproull and Kiesler 1991). Reprocessability affects information processing by allowing a recipient to spend more time decoding messages, by revisiting prior messages for additional consideration, and by providing a memory that can help new participants understand past activities (Nunamaker et al. 1991). The reprocessability of a medium can impact the transmission of information since it enables both senders and recipients to reread and reconsider prior messages before engaging in communication.

Reprocessability is important for information processing as it enables the sender to reexamine and consider previously sent content for the development of understanding; it is especially important for transmission of new, complex, or large volumes of information. The availability and use of reprocessability allows individuals to revisit messages to support information processing and understanding development (Weick and Meader 1993). In general, reprocessability is more important for conveyance processes because they have greater needs for processing. Convergence, on the other hand, has a lesser need for reprocessability as the focus is on the mutual construction and adjustment for shared meaning development. While reprocessability could help convergence by supporting information processing (revisiting a discussion after the fact to ensure understanding), it is not a primary driver for communication performance due to the importance of shared focus and interaction.

However, reprocessability can create delays in the transmission of messages because receivers can take longer to review and deliberate on previously received messages. Like rehearsability, this is not specifically an impediment of the transmission velocity of the medium itself; rather it is due to the way in which receivers appropriate and use the medium to reprocess information before responding to messages. This may lead to delays in information transmission, to the benefit of information processing. As a result, reprocessability may reduce synchronicity as it impairs the development of coordinated behavior and focus. Therefore,

P6: Reprocessability lowers shared focus, which will have a negative impact on a medium's capability to support synchronicity.

Media Appropriation

Although we recognize that users choose how and when to use media, it is important to remember that the capabilities offered by communication media both enable and *constrain* behavior (Wheeler and Valacich 1996; Yoo and Alavi 2001). Media can shape user behavior by making it easier for users to interact in some ways and more difficult to interact in other ways (Dennis and Reinicke 2004). Although users are free to choose how they adopt and use different media, media often create dominant appropriation paths (Dennis and Reinicke 2004); that is, while users can choose (within limitations) to do what they like, the fit between the capabilities of the media and the needs of the task influence how users choose to adopt and use them (Dennis et al. 2001; DeSanctis and Poole 1994). For example, although it is possible to use e-mail synchronously, it is less suited to this than instant messenger or telephone, so with experience, users are less likely to choose to

use e-mail in this way. Media that fit user needs well are more likely to be faithfully appropriated and used; media that do not fit the needs of the user very well are less likely to be faithfully appropriated and used (see Figure 1).

Appropriation is also influenced by other factors (Majchrzak et al. 2000). For example, familiarity with and training on the use of the media can increase the likelihood that the media will be appropriated faithfully (Dennis et al. 2001; DeSanctis and Poole 1994; Wheeler and Valacich 1996). Positive past experience and social norms can influence the likelihood that the media will be appropriated faithfully (DeSanctis and Poole 1994; Jasperson et al. 2005; King and Xia 1997). Consequently, we can argue that better communication performance may result if an individual uses the telephone to generate agreement on a plan of action (higher synchronicity matched with a convergence communication process), but if the individual is concerned that they will state their arguments poorly, better communication performance may actually be obtained through the use of e-mail or writing a note instead, as both of these media allow the sender to rehearse their arguments before presenting them.

Conclusions about Media Capabilities

Table 2 compares several commonly used media on these five capabilities, and the resulting impact on information transmission, information processing, and synchronicity. In several cases, media are listed as having a range of capabilities because they are configurable and can be appropriated and used in different ways. For example, some instant messaging systems only allow text, while others permit voice, video, and shared applications. Likewise, specific devices may be hard to categorize as they provide multiple capabilities: a blackberry, for example, provides telephone, e-mail, text messaging, and so on, so the capability of a device and how it affects synchronicity will depend upon which communication medium is used (e.g., voice, e-mail, text messaging) and how that medium is used. In these cases, it is necessary to examine the underlying media capabilities provided and used, rather than considering the device itself as a single entity.

This table does not suggest that individuals must use certain media in certain ways; it just presents conclusions about the resulting capabilities when media are used in these ways. E-mail, for example, can be used in a near-synchronous manner, which would provide a set of capabilities more similar to that of synchronous electronic conferencing. It is also possible to combine media.

Table 2 reinforces two important conclusions that are often overlooked when considering new, digital media. First, media

are not monolithic. It is possible for one medium to possess different levels of a communication capability depending upon how it is configured and used (e.g., one instant messaging system may have limited symbol sets, while another includes graphics and video) (Bretz 1983; Heeter 1989; Walther 1992).

Second, there is an inherent paradox between information transmission and information processing (Robert and Dennis 2005). Media that have strong capabilities to support information transmission typically lack strong capabilities to support information processing and vice versa. No one medium has the best values for both information transmission and information processing, so no single medium could be labeled as most appropriate for a task. Media possess many capabilities, each of which may be more or less important in a given situation. The “best” medium is that which best provides the set of capabilities needed by the situation: the individuals, the *communication processes*, and the social context within which they interact. In the age of digital media, concluding that face-to-face communication is best suited to equivocal tasks is not appropriate (Bretz 1983).

MST proposes that the “best medium” for a given situation may be a combination of media (e.g., Shahriza et al. 2005; Watson-Manheim and Belanger 2007). For example, consider a convergence process conducted face-to-face versus one conducted using a virtual whiteboard system. Face-to-face communication is more capable of supporting synchronicity, and thus we could expect the development of shared understanding to proceed more effectively and efficiently using it. Now, consider adding a whiteboard (virtual or otherwise) to the face-to-face discussion. Although we argued in Proposition P4(b) that media with written or typed symbol sets are less capable of supporting synchronicity, the combination of face-to-face communication (with its ability to support synchronicity) and the whiteboard (with its ability to enable reprocessability) may be better able to support the development of shared understanding than either medium alone. By balancing the strengths and weaknesses of media we can improve communication performance.

Communication in Context: Interactions over Time

The previous sections defined tasks as a series of fundamental communication processes (conveyance and convergence) and then explained how different media capabilities supported these two communication processes by providing higher or lower levels of synchronicity. The context in which communication occurs can have a significant effect on the need for

Table 2. Comparison of Selected Media and Their Capabilities

	Transmission Velocity	Parallelism	Symbol Sets	Rehearsability	Reprocessability	Information Transmission	Information Processing	Synchronicity
Face-to-face	High	Medium	Few-Many	Low	Low	Fast	Low	High
Video Conference	High	Medium	Few-Medium	Low	Low	Fast	Low	High
Telephone Conference	High	Low	Few	Low	Low	Fast	Low	Medium
Synchronous Instant Messaging	Medium-High	Low-Medium	Few-Medium	Medium	Medium-High	Medium	Low-Medium	Medium
Synchronous Electronic Conferencing	Medium-High	High	Few-Medium	Medium	High	Medium	Medium	Low-Medium
Asynchronous Electronic Conferencing	Low-Medium	High	Few-Medium	High	High	Slow	High	Low
Asynchronous Electronic Mail	Low-Medium	High	Few-Medium	High	High	Slow	High	Low
Voice Mail	Low-Medium	Low	Few	Low-Medium	High	Slow	Medium	Low
Fax	Low-Medium	Low	Few-Medium	High	High	Slow	High	Low
Documents	Low	High	Few-Medium	High	High	Slow	High	Low

particular types of communication processes (Ballard and Seibold 2004; Carlson and Zmud 1999; Habermas 1984; Mennecke et al. 2000; Te'eni 2001; Zack 1994). We examine the context in which communication occurs and identify three factors that influence the relative amount of conveyance and convergence processes: the familiarity that individuals have with each other, with the task, and with the communication media they use. We believe that these three factors hold important implications for the impact of media use on communication performance (Carlson and Zmud 1999; Kock 2004).

Thus far, we have not discussed the *content* of the task (e.g., decision making, relationship building, idea generation). We believe that the best theoretical focus is on the communication processes needed, not on the overall task as a whole. However, one overarching task characteristic that influences communication process needs is the extent to which the task is additive or conjunctive (Shaw 1981)—in other words, to what extent can individuals work separately on the task versus the amount of coordination and interaction needed. Some tasks inherently require more coordination and interaction than others; decision making, for example, requires more interaction and coordination than idea generation (Shaw 1981). However, different individuals performing the same task may exhibit quite different needs for coordination and interaction. The familiarity that individuals have with each other, the task,

and the media will influence the amount of coordination and interaction, and subsequently the amount of convergence or conveyance required.

We use McGrath's (1991) time, interaction, and performance (TIP) theory as the foundation for understanding the amount of coordination and interaction needed. TIP theory argues that individuals working with others perform three simultaneous functions over the course of multiple concurrent projects. One function consists of activities that contribute to the organization to which they belong (the production function). The other two functions consist of activities that build and strengthen relationships with others (team well-being) and activities that help individuals personally develop (member support); we combine these into the social function.¹²

Within these two functions (production or social), McGrath proposes that individuals can be engaged in any of four modes of operation. *Inception* is the understanding of task goals and the selection of a strategy. *Technical problem solving* is the resolution of issues about how the task will be accomplished,

¹²Although McGrath identifies these two as separate elements, group well-being and member support have also been combined in previous research (e.g., Bales 1950; Huang and Wei 2000; Marks et al. 2001; Yoo and Alavi 2001).

such as understanding criteria or role issues. *Conflict resolution* is the resolution of conflicting preferences, values, interests, assignments, and rewards. *Execution* is the set of behaviors necessary to carry out the goals.

There is no inherent order to these modes, except that all tasks start at inception and move to execution (McGrath 1991). Tasks could start in inception, move to execution, and then to technical problem solving. Depending on the familiarity with the task, the individuals, and media, individuals may have to perform different modes for different communication purposes simultaneously (e.g., problem-solving in the production function, and execution in the social function).

Different modes require different communication processes. We argued earlier that for most tasks, individuals will use *both* conveyance and convergence and that depending on contextual factors, the relative mix of these communication processes will differ. Figure 3 shows three task contexts (identified by the familiarity with the task, other individuals, and media) that differ in their need for conveyance and convergence. The relative importance of conveyance and convergence processes within each mode is identified by the size of the shaded and non-shaded areas. Bold arrows indicate a typical flow among modes over time while dashed arrows indicate possible flows.

Familiar Communication Context

Figure 3(a) illustrates the case in which individuals have experience working with each other, the task, and the media, although they may not necessarily have previously worked together on this task using these media. Such individuals will have well developed roles and norms so they should quickly proceed from inception to execution using habitual routines (Gersick and Hackman 1990) and references to shared mental models. Inception will likely consist of the dissemination of goals and issues with rapid agreement; conveyance processes should be common. Convergence processes will be short because individuals will enact shared mental models (Carlson and Zmud 1999; Fulk et al. 1987; Kock 2004; Minsky 1986; Schmitz and Fulk 1991). Individuals will quickly move to execution, where they can work independently (McGrath 1991) since shared goals, work processes, roles, and norms from previous experiences will be quickly enacted (Gersick and Hackman 1990). Execution will require more conveyance than convergence, although some convergence will be required.

Variances in results, unexpected outcomes, or problems will trigger problem solving and conflict resolution activities, but

not to the degree expected in tasks that are completely unfamiliar (Te'eni 2001). Nonetheless, we can expect problem solving and conflict resolution to require more convergence, as the trigger for these modes is often a lack of shared understanding. The mix of convergence and conveyance processes will depend on the nature of the task; if the task has many new or different variables, more convergence processes will be necessary. We may expect a pattern or a rhythm in which conveyance processes in execution are interspersed by convergence processes during problem solving and conflict resolution (e.g., Maznevski and Chudoba 2000). Thus the use of media may follow somewhat predictable patterns as a quick jump to execution leads to conveyance using low synchronicity media, followed by phases of convergence with media having higher synchronicity (Jones et al. 1994; Saunders and Jones 1990).

Novel Communication Context

Figure 3(b) illustrates the case where individuals will have no experience working with each other, the task, or the media. Inception will be more complicated. It will emphasize convergence processes more than conveyance processes as individuals attempt to *develop* shared interpretations of the goals and strategies for performing the task (Hollingshead et al. 1993; Kock 2004; Warkentin et al. 1997). Conveyance processes will be necessary as individuals share ideas and experiences, but convergence processes will play a larger role to ensure that all individuals have similar understandings (McGrath 1991; Kock 2004; Te'eni 2001; Tschan 1995). Problem solving and conflict resolution will be common to revise understandings and come to consensus on activities (Burke and Chidambaram 1999; Gersick and Hackman 1990; McGrath 1991; Tschan 1995; Walther 1992). Problem solving will utilize conveyance processes to gather and distribute information and convergence processes to come to agreement on solutions. Conflict resolution will similarly require a mix of conveyance and convergence processes as individuals share opinions, points of view, beliefs, and positions in order to converge on a common resolution.

Execution will not follow a pattern of conveyance using low synchronicity media followed by convergence with high synchronicity media (Jones et al. 1994; Saunders and Jones 1990). Instead, convergence processes will be more important initially as individuals develop shared understanding. Then, execution activities should require more conveyance of status and work (McGrath and Hollingshead 1993) and convergence will decline as the individuals develop shared mental models for working together (Gersick and Hackman 1990; Kock 2004).

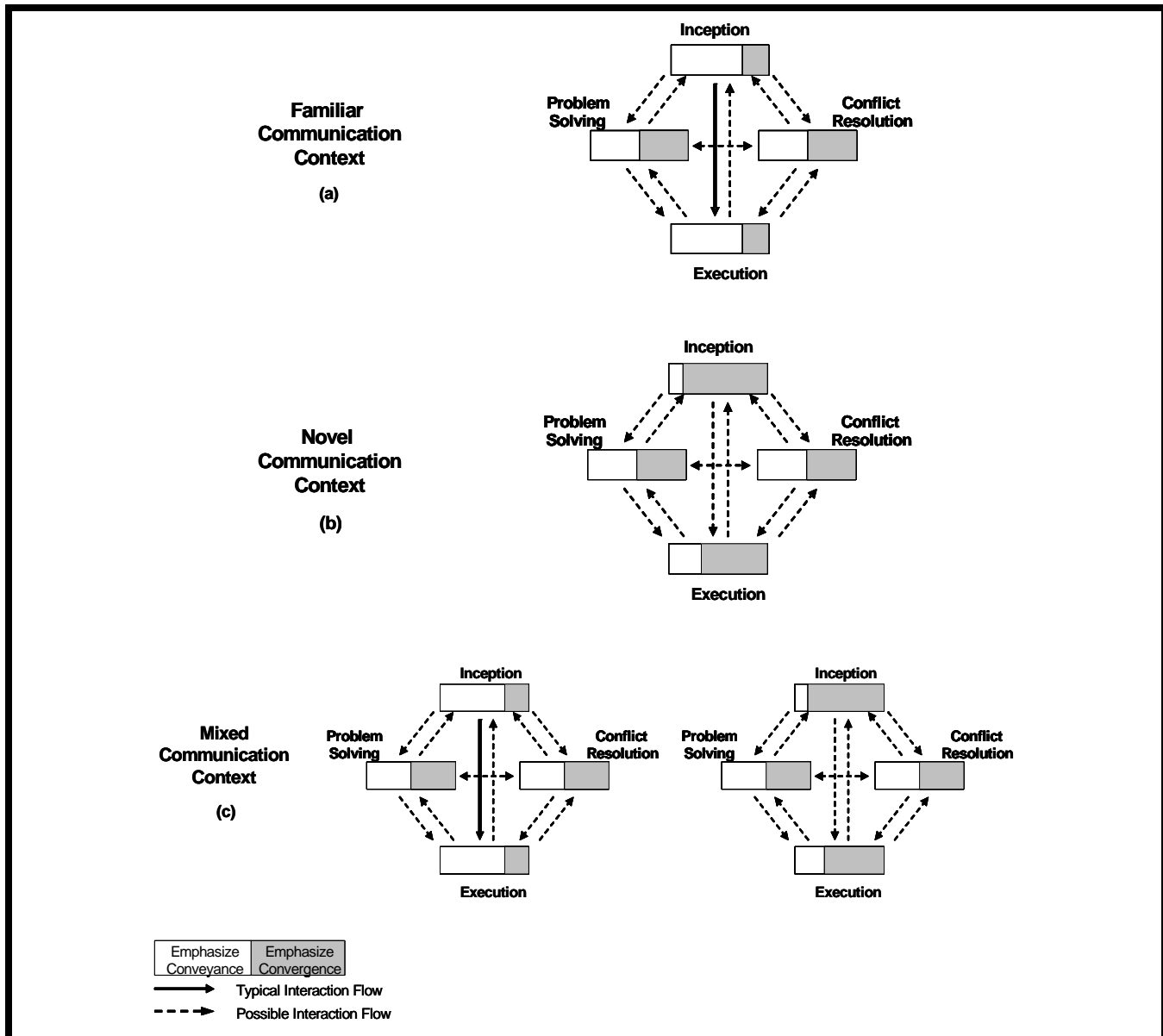


Figure 3. Framework for Groups, Tasks, and Mix of Communication Processes (adapted from McGrath 1991)

Mixed Communication Context

It is also possible that individuals may be familiar with each other, but be asked to work on a novel task or use unfamiliar media (or some other novel-familiar combination). Figure 3(c) illustrates the case when individuals are familiar with each other, but are asked to work on a task new to them or use media new to them. In these cases, individuals may move quickly from inception to execution in the social function

(since the individuals know each other) but require greater convergence processes for inception and execution within the production function because the task and/or media are new to them (McGrath 1991). In cases of mixed familiarities, the balance of conveyance and convergence may be different between the production and social function, but since the production and the social functions occur simultaneously it is hard to predict the specific communication patterns as they work together.

Summary

In this section, we identified three contexts that suggest differing needs for individuals to perform convergence or conveyance processes, depending on the degree of familiarity the individuals have with the task, with the media, and with each other. Most individuals will employ both conveyance and convergence and thus require a mix of media that support each process to improve communication performance. When individuals have extensive experience with the task, with the media, and with each other, we would expect fewer convergence processes and thus less need for media supporting synchronicity. In contrast, for individuals who have little experience with the task, media, and each other, we would expect more use of convergence processes and thus a greater need for media supporting synchronicity. Therefore,

P7: Although individuals working together on tasks will benefit from the use of both high and low synchronicity media, their need for media synchronicity will depend on their level of familiarity with each other, with the task, and with the media.

- (a) Individuals working together with well established norms working on familiar tasks using familiar media will have the least need to use media supporting high synchronicity.
- (b) Individuals working together without well established norms working on unfamiliar tasks using unfamiliar media will have the greatest need to use media supporting high synchronicity.

Over time, the communication context moves from the novel to the familiar. For example, individuals working together for the first time on a new task start in a novel context and will need to learn about each other and the task. As they work together on the task over time, they become more familiar with each other and the task. Given sufficient time, routines emerge and the context becomes familiar. For a given situation, as the communication context moves from novel to familiar, regardless of the function or mode, relatively fewer convergence processes will be needed. Thus, over time, individuals will have less need for high synchronicity media.

Discussion

MST proposes that communication performance will improve when the needs of conveyance and convergence processes are matched to appropriate media with the transmission velocity, parallelism, symbol sets, rehearsability, and reprocessability needed by those processes. In this section, we briefly review notable published work based on the initial version of the

theory, before using the revised version of MST to explain unexpected results from prior research. We then draw implications for future research and practice.

Empirical Research on Media Synchronicity Theory

The original version of MST has been used by 32 journal articles (according to ISI Web of Knowledge citation analysis¹³) and there are more than 70 citations to it by scholarly manuscripts available on the Web (Google scholar search). None of these studies, however, has tested the complete original version of MST; likewise, none has tested the complete revised version of MST. Although bits and pieces of the original and revised theory have been tested or built upon, much of this research is subject to some of the limitations of the original version of MST or have applied MST outside its boundary conditions.

For instance, Carlson and George (2004) use some of the concepts of MST to develop and test hypotheses about media choice when the intent is to deceive the other participants. Thus in contrast to the original intent of MST (to predict the ability of participants to develop shared understanding), this article uses the original MST concepts to predict media choice preferences when some participants are deliberately attempting to *not* develop shared understanding. Nonetheless, media synchronicity was found to play a role in media selection and perceptions of the ability to deceive and to detect deceptions.

Also, Murthy and Kerr (2003) tested parts of the original version of MST in a team context. They used MST to argue that individuals on teams using face-to-face verbal discussion would outperform teams using text-based computer-mediated communication when working on a problem-solving task (identify the most appropriate control procedure to correct each of 10 errors in an online sales processing system) while the reverse would be true for an idea generation task (developing a list of general control procedures for the IS department and its order processing system). This experiment tested MST at the level of the task rather than at the communication process level (which MST argues explicitly *not* to do), reasoning that problem solving would require more convergence and idea generation more conveyance and thus there should be differences. Despite treating task as a monolithic entity, it found general support for MST's propositions.

¹³Web of Knowledge does not report all citations to articles, just those in selected journals. For example, Carlson and George (2004), which we include in our discussion, is *not* listed among the articles.

Additionally, Maruping and Argawal (2004) used parts of the original version of MST in their development of a new task-technology fit theory. They use MST to define the key functionalities of communication technologies in their theory. However, rather than using the MST concepts of conveyance and convergence, they develop new theory about the developmental stages of teams and attempt to match the MST media capabilities to team's needs for conflict management, motivation, and affect management in different stages of team development. In their paper, the concept of task (in this case interpersonal process types) is treated as a monolithic entity that remains constant over time. Immediacy of feedback is considered a capability of media (following the arguments in the initial version of MST), which we now consider as a socially experienced outcome resulting from use, not a capability of the media itself. As such, the propositions presented in their paper would be strengthened with the new conceptualization of MST. The application of team development phases, media capabilities, and communication requirements of the interpersonal process types are theoretically consistent with this version of MST.

As described above, MST has been used in prior research, but there are many examples where its concepts have been misinterpreted or misapplied due to limitations in the original version of the theory. The constructs and definitions provided in this paper provide a much better theoretical conception of MST regarding media, communication tasks, and communication performance that enhance its application in future research on media and communication performance.

Media Synchronicity Theory and Prior Media Research

To demonstrate the utility of MST, we briefly reexamine prior research using the theoretical lens of MST in several cases where the predictions of MRT were not supported. We selected these studies because they adhered to the original purpose of MRT: to explain or predict how the *use* of certain media for a task would yield *performance*. A sample of studies is given in Table 3.

Two primary reasons for the failure of MRT are evident from Table 3: the conceptualization of task as monolithic, and the identification of media capabilities. Most prior research examining the impact of media on performance tends to use monolithic conceptualizations of task—for example, McGrath's (1984) circumplex or Daft and Lengel's (1986) uncertain-equivocal categorization. While these conceptualizations may be accurate, they are at too broad of a level to provide reasonable insight on how media can influence

performance. Research using these generalizations has been unsupportive of MRT, finding that individuals used "leaner" media than expected, switched among media rather than choosing one "correct" medium, or performed better than expected using an "incorrect" medium (Dennis and Kinney 1998; Markus 1994; Rice and Shook 1990).

The application of MST in these studies would have required that the research take a closer look at the communication *processes* performed, followed by an examination of the capabilities of the specific media used. With a finer-grained conceptualization of task as a series of communication processes, it is evident that individuals in these studies, regardless of the task or their organizational position, needed to perform both conveyance and convergence. Thus use of media lower in synchronicity by higher level of executives (e.g., Rice and Shook 1990) is not surprising as these individuals still must perform conveyance processes. Likewise, the failure to find differences across different task types (e.g., Mennecke et al. 2000) can be attributed to the need for both conveyance and convergence for all task types. MST would also suggest that an examination of the context of communication is necessary. In contexts where the individuals had familiarity with one another and the task (e.g., Markus 1994), they would likely have less need to perform convergence as opposed to conveyance. MST would suggest that while the communication appeared to require convergence, the communication process was primarily one of conveyance, as the participants already had shared mental models.

Prior research also uses characteristics of media as identified by MRT to describe and rank media and predict performance. Although these prior characterizations of media were true to the original tenets of MRT, they are likely part of the reason why recent research has failed to support MRT, particularly for newer media. In experimental research designed to explicitly test the predictions of MRT, reassessing the requirements of the tasks, as well as the capabilities provided by the media (as provided by MST) yields a different set of findings, supporting MST.

Examination of these studies suggests that the media tested did not differ in terms of the relevant capabilities required for the task. For a task where information transmission is important for communication performance, media such as synchronous messaging, face-to-face, and telephone do not differ significantly in transmission velocity. This is especially true given that much of the research involved communication between dyads (parallelism would be less of a factor) and that the information provided to the participants was often already in text form (e.g., Dennis and Kinney 1998; Kinney and Watson 1992; Mennecke et al. 2000) so less of a conversion

Table 3. Prior Studies and MST Explanations

	Unexplained Result	Media Synchronicity Theory Explanation
Rice and Shook 1990	Individuals in higher level positions were found to be more likely to use e-mail for their equivocal tasks.	The assessment of media use by high level managers did not consider the likelihood that the tasks performed by managers include both conveyance with deliberation and convergence on meaning. Higher level managers successfully used e-mail for data gathering (conveyance tasks) which benefit from increased parallelism, specific symbol sets, and rehearsability, all of which are provided by e-mail.
Kinney and Watson 1992	Consensus change did not differ as a function of the medium (less rich or more rich) used.	The media provided for all of the treatments provided similar levels of synchronicity in terms of transmission velocity and parallelism (dyads). While the symbol sets used differ (text and voice), this difference, given the task (text-based), was not enough to generate significant differences in performance. Therefore, no differences in performance would be expected between the different media treatments.
Markus 1994 (and Lee 1994; Ngwenyama and Lee 1997)	Managers used lean media (e-mail) for equivocal communication tasks, even strategy.	The examples provided of e-mail use, even for strategy tasks, show that managers used e-mail (lower synchronicity) to convey information (two to three page e-mails) and then would talk on the phone (higher synchronicity) to converge on an agreement regarding the contents of the e-mail, consistent with MST.
Dennis and Kinney 1998	Use of richer media did not lead to better performance (quality, consensus) on tasks of higher equivocality.	Participants had performed the task before, providing experience with the task and media. When meeting as a group, they had greater need to convey differences in information and their positions on the task, and less (although not nonexistent) need to converge on a decision. In this context, MST predicts that media emphasizing information transmission more than processing would enable superior performance. Since the media provided were similar regarding information transmission, no difference in results would be expected.
Burke and Chidambaram 1999	Despite the lower social presence of groups using synchronous media, distributed teams performed better than face-to-face teams on an equivocal (complex) task.	MST would predict that for this task, media providing transmission and processing support would enable superior performance since teams needed to convey information and converge on points of view. The synchronous media used by distributed teams provided these capabilities, as well as improved parallelism over face-to-face. Therefore, media teams were not slowed by individual speakers, were able to attend to the data required for the task, and were not distracted by other (facial, verbal) symbol sets.
Mennecke, Valacich, and Wheeler 2000	The pattern of objective performance was not consistent across tasks and media. Significant differences in performance for conflict and intellective tasks were not found when different media were considered.	The media tested were all similar in terms of transmission capabilities: transmission velocity (immediate), parallelism (dyads), and given the task, text symbol sets would be appropriate. For the tasks utilized, media capabilities for processing would be less likely to impact task performance. MST would predict that it is unlikely significant differences would be found for task performance, as the relevant media capabilities (for transmission) provided to perform the tasks were similar.

was necessary to communicate the information. Likewise, for tasks where convergence is required, the media did not significantly differ on those capabilities that would affect communication performance: transmission velocity and symbol sets. However, the media did differ on parallelism, which may have caused teams using synchronous electronic media to be more focused on the task, and minimized serial communications as experienced in face-to-face teams (e.g., Burke and Chidambaram 1999). We feel that by using the more relevant

media capabilities described by MST, more accurate predictions and explanations will result.

Implications for Future Research and Practice

The propositions and concepts underlying MST suggest several opportunities for future research. In any of the primary areas in Figure 1, communication processes, media

capabilities, appropriation factors, and communication performance, there are opportunities to expand and test our propositions, to refine the model, and to test its boundary conditions. Future research could examine the relationship between media capabilities and communication processes and the degree to which specific configurations of media capabilities (both transmission and information processing oriented) are more or less beneficial for one or both processes.

Future research could also examine to the degree to which various factors influence appropriation and use. Given that these factors have the potential to moderate the relative benefits of media capabilities for supporting various processes, understanding their interplay would aid in better understanding communication performance. Likewise, additional research is needed to examine communication performance outcomes in more detail, notably the development of understanding. Adequate explication of this complex issue would be beneficial not only to media research, but in research that considers the impact of media capabilities as they influence information transmission and processing, such as knowledge exchange in a variety of contexts. Likewise, the relationship between communication performance and task performance requires examination to determine the degree to which certain task types (e.g., additive, serialized) benefit or are not influenced by varying levels of communication performance.

Future research also needs to address the extent to which media capabilities will actually be appropriated and used. For example, some individuals prefer polychronic interaction, and will be more comfortable using parallelism than others who prefer monochronic interaction and may choose to avoid it (Lee 1999). Likewise culture may influence how individuals choose to interact; individuals from some cultures may take more time for reflection and deliberation, even when using media that do not encourage such reflection (Lewis 1999). In addition to cultural issues, a vast array of individual factors will likely influence media appropriation and use (e.g., absorptive capacity, Cohen and Levinthal 1990; introversion/extraversion, Topi et al. 2002; cognitive ability, Valacich et al. 2006).

Communication needs are usually different for individuals working in novel contexts than in familiar contexts, which has important implications for laboratory research. Most laboratory research (including some of our own) has been done with *ad hoc* groups of students using software new to them. By placing these individuals in novel contexts, we have artificially increased the need for convergence processes, when the same tasks performed by experienced individuals using familiar tools could be performed as successfully with less use of media capable of supporting convergence. This may be

one reason why experimental research has often found higher task performance with media supporting convergence where field research has not.

The changing balance of conveyance versus convergence processes as individuals, tasks, and media move from the novel to the familiar has implications for media use over time. Media that best fit the novel, first time performance of a task, may not be the best fit for ongoing use. For example, Fuller and Dennis (forthcoming) found that the traditional prescriptions of using high synchronicity media for decision-making tasks only led to better performance when the task was novel; as the task became familiar, low synchronicity media led to equal or better performance.

MST also has implications for practice. Because most tasks require both conveyance and convergence, the use of a single medium will likely not lead to ideal communication performance. "Richer" is not "better." The use of multiple media, either concurrently or consecutively, will lead to better communication performance, because no one medium provides the ideal combination of capabilities for both conveyance and convergence. At the extreme, use of many media simultaneously (e.g., talking on the phone while engaging in several IM chats) may result in cognitive overload, leading to reduced information processing (Schultze and Vandenbosch 1998) and impaired communication performance (Miranda and Saunders 2003).

In supporting remote workers or virtual teams, media must be considered in terms of the capabilities they provide since the communication processes needed for a task may require different media capabilities. Managers implementing communication technologies should understand the nature of the individuals and the context in which they will work, as this may suggest differing requirements for media capabilities. While some contexts may benefit from media with higher synchronicity (novel contexts), for others (familiar contexts) high synchronicity may not be needed, and may even be detrimental. Understanding the context provides insight as to the appropriate mix of media. It is also important to note that these needs are likely to change over time, as teams move from the novel to the familiar, so the ideal set of media for project initiation may not be ideal once the project is underway (Fuller and Dennis forthcoming).

Conclusion

We argued that communication performance will be improved when media capabilities that affect information transmission,

individual information processing, and synchronicity are matched to fundamental communication processes (conveyance or convergence). Most tasks require individuals both to convey information and to converge on shared meanings. Conveyance processes are best served by media with capabilities that support low synchronicity while convergence processes are best served by media with capabilities that support high synchronicity. Thus choosing one single medium may prove less effective than choosing a set of media. Face-to-face communication is not always the richest medium, and, richer is not necessarily better.

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About the Authors

Alan R. Dennis is a professor of Information Systems and holds the John T. Chambers Chair of Internet Systems in the Kelley School of Business at Indiana University. He is a senior editor at *MIS Quarterly*, and the founding publisher of *MIS Quarterly Executive*. He has written more than 100 research papers and four books (two on data communications and networking, and two on systems analysis and design). His research focuses on four main themes: the use of computer technologies to support team creativity and decision making; knowledge management; the use of the Internet to improve business and education; and professional issues facing IS academics (e.g., business school rankings and the difficulty of publishing and getting tenure in IS).

Robert M. Fuller is an assistant professor of Information Systems in the College of Business Administration at the University of Tennessee. His research interests focus on the fit and use of collaborative technologies for team performance, the adoption and use of communication technologies, and the improvement of requirements elicitation through semi-structured communication techniques. His research has appeared in the *Journal of the Association for Information Systems*, *Decision Support Systems*, and *Journal of Computer Information Systems*, among others.

Joseph S. Valacich is the George and Carolyn Hubman Distinguished Professor of MIS at Washington State University. He was previously an associate professor with tenure (early) at Indiana University, Bloomington, and was named the Sanjay Subhedar Faculty Fellow; he also has had visiting faculty appointments at the University of Arizona, City University of Hong Kong, Buskerud College (Norway), Norwegian University of Life Sciences, Riga Technical University, and Helsinki School of Economics and Business. He received his Ph.D. degree from the University of Arizona (MIS), and M.B.A. and B.S. (computer science) degrees from the University of Montana. He has conducted numerous corporate training and executive development programs for organizations, including AT&T, Boeing, Dow Chemical, EDS, Exxon, FedEx, General Motors, Microsoft, and Xerox. He currently serves on the editorial boards of *MIS Quarterly*, *Decision Sciences*, and *Small Group Research*. He was the general conference co-chair for the 2003 International Conference on Information Systems in Seattle and was the vice-chair of ICIS 1999 in Charlotte. His primary research interests include human-computer interaction, technology-mediated collaboration, mobile and emerging technologies, e-business, and distance education.