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Context Counts: Effects of Work versus Non-Work Context on Participants' Perceptions of Fit in E-mail versus Face-to-Face Communication

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Abstract:

There is a general need to understand better how context can affect evaluation, usage, and productivity of IT in research and practical settings. This paper investigates how perceived effectiveness of e-mail-style computer-mediated communication (CMC) differs between work and non-work contexts of use, and contrasts these differences with perceived effectiveness of face-to-face communication (FtFC). From the prior literature, we identified seven major activity domains that are prominent in CMC research. We developed a set of activity scales and corresponding measures of normative cognitive effort (NCE) for these domains and conducted an initial study to evaluate the overall instrument. In a second study, we measured perceived effectiveness of the communication mode within each activity domain among subjects who had communicated via e-mail and FtFC over a 15-week period. Some subjects communicated to support team-based software development (work context), and others communicated for personal interest (non-work context). We find communication technologies, activities, and contexts of use jointly determine perceived effectiveness; context influences perceived effectiveness primarily through interactions; and NCE successfully predicts perceived effectiveness based upon normative differences among activities. Our findings extend prior research in the area of task-technology fit to incorporate context effects, suggest that context is an important consideration in designing research, and introduce NCE as a method for predicting fit that can be applied even prior to system design. We conclude that the differential effects of work vs. non-work contexts are too large to be ignored, and we recommend an increased focus on context effects in CMC research and practice.

Keywords: CMC, computer-mediated communication, context, task-technology fit theory, cognitive effort, task types, group task circumplex

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Communications of the Association for Information Systems

I. INTRODUCTION

To what extent are user perceptions of e-mail and similar computer-mediated communication (CMC) technologies determined by the context in which communication occurs, and how do these differ from perceptions of face-to-face communication (FtFC) in similar contexts? These are important questions for researchers, as they underlie the assumption of external validity necessary to generalize findings from one research setting to another [Zack and McKenney 1995]. The question is equally important to everyday users of CMC, who must decide whether this technology will be effective in novel contexts based on their prior communication experiences [Wilson 2002].

This paper extends task-technology fit theory [Goodhue 1995] to investigate effects of work context versus non-work context in the use of e-mail-style CMC versus FtFC for seven common activities—four related to tasks, two to social actions, and one to message conveyance. Although we are primarily interested in understanding how context influences user evaluations of CMC, we include FtFC measures in the research both to provide a baseline measure for comparison purposes and to promote relevance of the findings to the substantial existing literature that contrasts CMC and FtFC. Numerous studies have been conducted in a work context or a non-work context, but we find no prior studies of CMC and FtFC that address *both* contexts.

Systematic differences between work and non-work contexts could limit the validity of much of the CMC literature as well as hinder practical uses of CMC technologies. As described in following sections of the paper, there is good reason to anticipate that systematic differences do exist between these contexts. Thus, the goal of this paper is to conduct research that is sufficiently comprehensive to identify areas where differences occur and to allow findings to be related back to the existing literature.

In the next section we define the terms under discussion and review theoretical and empirical background literatures, giving special attention to studies that compare multiple communication contexts and studies that specifically address communication in representative work or non-work contexts. This is followed by an explanation of our research model, development of hypotheses, presentation of the research method and results, and a discussion of the findings.

II. COMMUNICATION TECHNOLOGIES AND CONTEXT

Drawing from a general definition of technology [Merriam-Webster 2006], we use the term "communication technology" to mean *a manner of accomplishing communication using specialized processes, methods, or knowledge.* The present research focuses on two modes of communication technology represented by e-mail-style[1] CMC and FtFC. Both modes of communication require the use of specialized processes, methods, and knowledge in order to participate effectively. FtFC requires skill in performing a substantial inventory of verbal and nonverbal behaviors that have been established through social and cultural mechanisms.[2] E-mail communication requires additional skill in the use of computer system features [Wilson 2005], but computer mediation also obstructs many characteristics of verbal behaviors, e.g., volume and inflection, and precludes most nonverbal behaviors, e.g., eye contact and facial expressions [McGrath and Hollingshead 1994]. As discussed in detail in a later section, differences between CMC and FtFC are found to occur in user processes (e.g., affect for other participants), subjective evaluations of outcomes (e.g., satisfaction with results), and objective products of communication (e.g., compliance with a request). One objective of the present research is to identify systematic differences between FtFC and CMC communication that are dependent upon the context in which the communication technology is used.

The term "context" is applied in this paper to mean a set of circumstances surrounding use of a communication technology. "Context is what the technology—that is, the material artifact—is introduced into; it is what is left behind

[1] In addition to e-mail, our literature review and discussion consider studies of other text-based CMC systems, including online discussion lists, online chat, and communication components of group support systems (GSS). Although these systems vary in certain characteristics, e.g., communication synchronicity, they offer similar system features to their users, including an emphasis on textual communication [McGrath and Hollingshead 1994]. In the remainder of the paper, we use the term *CMC* to refer to this general class of text-based systems.

[2] It also is argued that human communication incorporates inherited aptitudes and traits that predispose humans toward language use [Chomsky 1959, 1995]. Because such *predispositional* factors are genetically based and do not represent specialized processes, methods, or knowledge, we do not include these in our discussion of communication technologies.

when the technology leaves. Thus, the importance of context is as the necessary backdrop for technology" [Jackson 1996, p. 238].

In the few cases where context has been studied in communication technology research, results show that important effects can arise from diverse sources. Our literature review identified seven such studies which are summarized in Table 1. These studies apply a range of research designs and address a variety of contextual factors, yet their findings point to a common theme—the idea that *context counts* in determining how a communication technology is used and what outcomes result from using it. However, coping with the large variety and extensive variability of contextual factors that could be relevant to any specific research design presents a serious challenge to researchers.

Variety describes the number of factors through which context effects may be expressed. In a review of GSS communication studies, Fjermestad [2004] identifies 19 major categories of contextual factors that have been investigated, ranging from design factors, such as room configuration, to the cultural background of group members. The sheer volume of contextual factors that are potentially relevant to use of a specific communication technology precludes research designs from exhaustively testing joint effects of more than a few factors at a time.

Variability occurs as individuals transition between different contexts during use of a technology, such as e-mail accessed on a mobile device while traveling versus a home computer [Pascoe, Ryan, and Morse 2000]. Variability among contextual factors that are relevant to use of a given communication technology increases as the technology becomes more mobile [York and Pendharkar 2004] and as it is incorporated into more activities, e.g., using a laptop computer to support outside sales calls [Engle and Barnes 2000]. As variability of context increases, this implies that it will be necessary for field studies to address contextual factors as predominating tendencies rather discrete conditions and that findings from lab experiments controlled within a single context will increasingly lack relevance to practical settings.

Table 1. Context Effects Reported in CMC Research

Source	**Contexts Studied**	**Reported Context Effects**
Bikson and Eveland, 1990	Retirees vs. current employees as members of retirement task forces	Retired members predominate interactions in the e-mail-supported task force, and currently employed members predominate interactions in the FtFC-supported task force.
Dennis, Wixom, and Vandenberg, 2001	Idea generation vs. decision making	Group tasks with high requirements for interdependent actions (e.g., decision making) are better served by richer, more redundant technologies; FtFC is superior to CMC for such tasks.
Orlikowski, 2000	Lotus Notes users in three separate organizations	Notes is used in widely varying ways depending on characteristics of the organizational context.
Sussman and Sproull, 1999	Delivering bad news vs. good news	Bad news is delivered more directly and with less positive distortion using online chat than via FtFC.
Walsh and Bayma, 2001	Scientists working in math, physics, chemistry, or experimental biology	Evaluation of e-mail is associated with field of study and institutional tier of the e-mail user.
Wilson, 2002	Students in high interaction vs. low interaction classroom settings	Subjects in low-interaction context perceive e-mail as more effective for communication relating to task, socialization, and interpersonal influence than subjects in high-interaction context.
Zack and McKenney, 1995	Newspaper editorial teams in decentralized-participatory vs. centralized-hierarchical social contexts	The decentralized-participatory team reports stronger communication ties among editorial functions, rates CMC as more effective, and produces higher quality newspapers using CMC.

As a result of the challenges presented by variety of contextual factors and variability between contexts, relatively few studies address effects of context in use of communication technology. Of the studies Fjermestad [2004] analyzes, most simply contrast CMC to FtFC within a single experimental or organizational context. As illustrated by the studies we identified in Table 1, contextual factors can be important determinants of research results, and it follows that these factors can confound the results of research designs that do not take context into account. For this reason, it is important to develop research that addresses context despite knowing in advance that this will be messy work. Thus, a second objective of the present research is to evaluate theoretical perspectives on researching effects of context in the use of communication technologies. This issue is discussed in the following section.

Theoretical Perspectives on Context and Technology

It is straightforward to define context, yet there is substantial disagreement in the scientific community as to how (or whether) to incorporate context into research designs. Dervin [1997] describes a continuum in which researchers at one pole consider context to be relatively unimportant, dismissing all contextual factors except those clearly related to the object of study. Researchers at the other pole consider context to be the central source of meaning, essential for understanding the object of study. In the information technology (IT) literature, we find three generalized approaches have emerged that represent dispersed points on the continuum Dervin describes. We categorize these as low-dependence, unidirectional, and interdependence approaches, based on the assumptions underlying each approach (see Table 2).

Table 2. Research Approaches to IT and Context

Characteristic	Low-dependence Approach	Unidirectional Approach	Interdependence Approach
Research assumptions	IT and context are independent or dependencies are unimportant.	IT is dependent upon context.	IT and context are interdependent.
Theoretical perspectives: Orlikowski [1992], addressing interaction of technology and organizations	*IT as objective force:* Technology determines organization properties.	*IT as social construct:* Technology determined by strategic choice and social action	*Duality of technology:* Technology is interpretively flexible
DeSanctis and Poole [1994], addressing group support systems (GSS)	*Decision-Making School:* Context is subordinated to engineering features.	*Social Technical School:* Context moderates effects of technology.	*Adaptive Structuration:* Technology and context change one another over time.
Jackson [1996], addressing communication technology	*Determinism:* Context is separable from technology.	*Context as filter:* Changes in context affect technology.	*Integration:* Context and technology are interdependent.
Johnson [2003], addressing information seeking behavior	*Situation View:* Context is described through elaborate specifications.	*Contingency View:* Context is matched with process characteristics.	*Frameworks View:* Context is interrelated with process.
Typical research use	Study IT within a single context	Study IT within multiple contexts	Study changes in IT and context over time
Example theories	Technology Acceptance Model (as described by Davis [1989])	Social Technical Theory	Adaptive Structuration Theory
Key strengths of the research approach	Tight focus and simplicity of design	Ability to test effects of context	Ability to test feedback effects

The *low-dependence* approach assumes that technology produces consistent and predictable outcomes [Jackson 1996]. Context is considered primarily as a boundary constraint or "situation" which can be accounted for by detailed specifications of context characteristics [Johnson 2003]. Multiple contexts are not studied. A large portion of CMC research implements low-dependence research designs, but a number of weaknesses have been identified in this approach. First, many contextual factors are relevant to CMC, including characteristics of individuals, organizations, and physical settings [Fjermestad 2004] This makes it difficult for researchers using the low-dependence approach to ensure that studies are not confounded by some unforeseen spurious effect. Even a study that carefully accounts for one aspect of context (e.g., organizational characteristics [Ein-Dor and Segev 1982]) is likely to ignore other contextual factors (e.g., social influence [Fulk and Boyd 1991]). Second, the low-dependence approach is prone to confounds where the context is variable, whether variability arises from inconsistency [Jackson 1996] or systematic change. Third, this approach ignores transformational effects that the technology itself can have upon the context, which may in turn cause changes in subsequent evaluations or use of the technology [Mabry 2002; Orlikowski 1992; Poole and DeSanctis 1992]. For example, Orlikowski [1992] describes the case of a large software consulting firm's implementation of automated design tools, which greatly speeded production of certain types of computer screen designs but made it much more difficult to create custom screens. An unplanned effect of the new technology was to change organizational norms toward persuading clients to accept standard screen designs, thus transforming the nature of technology use within the firm.

The *unidirectional approach* seeks to "specify active ingredients in a context and their relationship to processes" [Johnson 2003, p. 740]. The unidirectional approach is used primarily to assess effects of context on technology. For example, Zack and McKenney [1995] link characteristics of the social context surrounding newspaper editorial teams to key differences in the perceptions, usage, and outcomes that are found in the teams' use of identical CMC technologies. By studying multiple contexts, researchers can expose confounding effects that would be hidden in a single-context design. Focusing on multiple contexts can also diminish what McGuire decries as the "corrupting effects" of hypothesis testing, in which researchers are motivated to choose the specific context in which hypotheses are likely to be confirmed and ignore all others [McGuire 1983, p. 14]. Alternatively, researchers may study longitudinal effects of context on technology. Orlikowski et al. [1995] used this approach to identify how deliberate intervention in the context of use can improve the quality of CMC over time, a process they term *metastructuring*. The unidirectional approach may also be used to study effects of technology on context characteristics [Jackson 1996; Wheeler 2001], however, this use is much less typical in the IT literature. Implementing a unidirectional approach adds complexity to research designs and requires care to ensure that the research includes essential contextual factors [Baker and Cullen 1993]. Further, as with the low-dependence approach, the unidirectional approach is open to the criticism that it has no ready mechanism to assess changes that occur dynamically between technology and context [DeSanctis and Poole 1994].

In the *interdependence approach,* technology and context are considered to be highly interrelated, if not inseparable. Each is assumed to have the capacity to change the other over time, through mechanisms including the structures and spirit that are represented [DeSanctis and Poole 1994], frameworks that constrain interaction [Johnson 2003], and interpretive flexibility achieved through human actions during design and use of the technology [Orlikowski 1992]. Thus, in applying this approach it is necessary for researchers to jointly define and observe the material effects of technology upon context and of context upon technology; process becomes the object of intense scrutiny [Poole and DeSanctis 1992]. Communication technology research has benefited from using the interdependence approach, particularly in designs that focus on changes occurring over time [e.g., Gopal and Prasad 2000; Majchrzak, Rice, Malhotra, and King 2000]. But for researchers intent on studying multiple contexts, the interdependence approach presents substantial challenges.

"If neither context nor technology is consistent and stable, models and theories of change must be capable of tracking and explaining effects as dynamic processes. In other words, if we introduce an electronic mail product into 20 different organizations, then, according to the assumptions of the integration perspective, we would say there now could exist at least 20 different electronic mail technologies" [Jackson 1996, p. 248].

In summary, each of the three research approaches offers a valuable, yet limited, lens through which to study IT and context. *None of these approaches is intrinsically bad or good.* Yet limitations differ in important ways among the approaches, and these differences constitute a basis for choosing an approach to best match research needs. We have chosen to apply the unidirectional approach in the present research, based on three considerations. First, we accept McGuire's argument that contextual investigations require "a program of research planned to reveal the wide range of circumstances that affect the phenomenon and the rich set of implicit assumptions that limit the theory, thus making explicit the contexts in which one or another relationship obtains" (i.e., prevails) [McGuire 1983, p. 22]. The practical need to study communication technologies across multiple contexts eliminates the low-dependence approach as an option. A second consideration stems from our objective to conduct research that is directly relevant to the existing CMC literature, in particular to those studies that address context effects. The bulk of such studies that we identified apply a unidirectional approach. This is the case in six of the seven studies profiled in Table 1; only Orlikowski [2000] implements an interdependence approach. This suggests that the interdependence approach is not necessarily a requirement for conducting effective research across multiple contexts. Third, we note that our planned research does not focus on areas in which the interdependence approach is clearly superior, such as studying dynamic effects of interdependencies between technology and context that occur over time. Thus, the inability of the unidirectional approach to account for these effects does not weigh heavily on our decision. In the next sections we present the theoretical basis of the contexts we propose to study and then review major activity domains in which differences between CMC and FtFC have been studied.

CMC in Work and Non-Work Contexts

Despite the insight that *context counts,* it remains difficult to generalize from the findings represented in Table 1 due to the idiosyncratic nature of communication technologies and narrow scope of contexts that have been investigated. This situation stems from inductive research traditions which "advocate progressively finer, feature-at-a-time evaluation of technology and more complex contingency classification schemes" [DeSanctis and Poole 1994, p. 124]. We propose that research in this area can benefit from an alternative approach that focuses on ubiquitous communication technologies (e.g., e-mail-style CMC and FtFC) and addresses contexts which are broadly relevant to the existing body of research and the experiences of technology users. Findings related to such overarching effects will help researchers to deductively develop organizing principles, interpret and generalize research findings, and highlight productive areas for future study.

The selection of contextual factors for this research was driven by the criteria that these should represent key dimensions within the existing CMC literature. These criteria are met by work and non-work, two high-level[3] contexts that dominate modern life [Neulinger 1976]. Although various distinctions are made between work and non-work[4], there is substantial agreement that essential differences between the two contexts are found in the degree of personal freedom (high in non-work; low in work) and source of motivation (intrinsic in non-work; extrinsic in work) that individuals perceive to exist [Parker 1983; Tinsley, et al. 1993; Tinsley and Tinsley 1988]. We use the term *work context* to describe situations in which the individual perceives communication to be constrained by external obligations (combining extrinsic motivation and low degree of personal freedom). The timing of communication, choice of communication partners, and topics of communication in a work context are determined largely by circumstances outside the individual's control. *Non-work context* is used to describe situations in which the individual perceives him/herself to be free to communicate at will. In a non-work context, the timing of communication, choice of partner, and communication topics are primarily driven by individual volition with the objective of satisfying personal interests.

Between the endpoints of work and non-work, there is a continuum formed by the balance of constraint and freedom [Parker 1983]. In addition, variability may be anticipated as individuals transition between work and non-work contexts while they are using a technology [Pascoe, Ryan, and Morse 2000; York and Pendharker 2004]. Nevertheless, we propose that work and non-work contexts of communication can be distinguished by ascertaining whether the motivation for communication within the context centers on external obligation versus internal volition.

It is important to note that the activities an individual performs are not bound to a specific context nor do they define the context. Indeed, we anticipate the same activities will be performed across both contexts. Social communication that occurs on the job and task-oriented communication that takes place during leisure time provide two practical examples of this distinction between activities and contexts.

Early CMC research and applications were implemented almost entirely within a work context, supporting such activities as national defense, computer-assisted instruction, scientific communication, and emergency preparedness planning [Hiltz and Turoff 1993]. However, it was recognized early on that users sometimes appropriated CMC for socializing and other non-work purposes [Steinfield 1986], especially in settings with significant personal freedom, such as universities and research centers. As Internet access proliferates, CMC has come to be used outside of work for socializing, playing games, and forming virtual communities [Baker 2000; Lea and Spears 1995; Parks and Floyd 1996; Whitty and Gavin 2001]. The result is that most people in industrialized nations now use CMC regularly during both non-work and work and for activities relating to personal interest as well as obligations. Caslon [2002] writes that 83 percent of respondents access e-mail daily for business purposes and 82 percent for non-work purposes, and Ewalt [2001] reports that 61 percent of e-mail is sent to family members and friends versus 39 percent to coworkers and business associates. Thus, there is a growing need to study CMC across work and non-work contexts, with the goal of integrating findings from studies that focus on various uses of CMC that occur during work with the current reality that for many CMC has become a ubiquitous part of life outside of work.

Activity Domains of CMC Research

Extensive literatures have emerged from the study of tasks, social activities, and message conveyance in CMC. In this section, we review these literatures to identify and categorize the major activity domains in which CMC is used across work and non-work contexts, noting that much of this research contrasts CMC to FtFC. It is important at this point to reinforce the distinction between our use of the terms *activity* and *context*. We view these as independent factors within the design of the present research, reflecting the observation that the studied activities may be performed in work or non-work contexts. Categorization of a work context or a non-work context is established by the degree of constraint versus freedom an affected individual perceives in performing activities rather than by characteristics of the activities being performed.

Task-Oriented Activity Domains

Much of the CMC research on task-oriented[5] activities manipulates communication technology (e.g., CMC vs. FtFC) within a controlled context and then tests for differences that arise in subjects' attitude formation or performance

[3] Characterization of work and non-work as high-level contexts is based on the view that context is a hierarchical structure that may be studied at varying levels of analysis (Johnson 2003). For example, Fjermestad's (2004) analysis of communication in GSS includes higher-level factors of environment and organization as well as lower-level factors of leadership and task characteristics. Where lower-level factors are studied, Johnson argues that these are subject to subordination by higher-level factors in the hierarchy, which must be accounted for when interpreting research findings. In the case of high-level contextual factors, such as work and non-work, effects are unlikely to be subordinated.
[4] Some authors recast this distinction as work vs. leisure (e.g., Parker, 1983).
[5] For brevity, task-oriented activities are denoted as *task activities* throughout the remainder of the paper.

[Fjermestad 2004]. This approach is highly compatible with established experimental design methods and norms. In some cases, task activity studies are conducted in what is clearly a work context, e.g., assessing employees at work [Alavi 1993] or studying students working on meaningful projects within long-term groups, such as software engineering teams [Wilson, Morrison, and Napier 1997]. However, many task studies use short-term designs in which it is difficult to implement high levels of external obligation that are representative of a work context. In particular, the task activity studies reviewed below that use volunteer student subjects in one-time research designs [e.g., Mennecke, Valacich, and Wheeler 2000; Straus 1999; Straus and McGrath 1994] represent a non-work context (combining intrinsic motivation and high degree of personal freedom), as subjects participated on their own volition and were subject to minimal external obligations.

A large portion of the CMC task research is based upon McGrath's group task circumplex model [McGrath 1984], which conceptualizes four major task processes: *generating* ideas and plans, *choosing* among alternative solutions, *negotiating* to resolve conflicts of viewpoint and interest, and *executing* performance and competition. Research that addresses specific task categories within the McGrath circumplex includes studies of brainstorming and idea generation [Alavi 1993; Gallupe, Bastianutti, and Cooper 1991; Jessup, Connolly, and Galegher 1990; Valacich Dennis, and Nunamaker, 1992], making intellective choices, i.e., choosing among a set of alternatives [Daly, 1993; Smith and Vanacek 1990], choosing through consensus [Dubrovsky, Kiesler, and Sethna 1991; Siegel et al. 1986], negotiating [Arunchalam and Dilla 1992; Fischer-Lokou and Gueguen 2001], and executing projects [Wilson et al. 1997]. In addition, a number of studies address more than one of these task categories [Dennis, Wixom, and Vandenberg 2001; Hiltz, Johnson, and Turoff 1986; Hollingshead, McGrath, and O'Connor 1993; McLeod and Liker 1992; Mennecke et al. 2000; Murthy and Kerr 2000; Straus 1999; Straus and McGrath 1994, 1996; Tan et al. 1999; Wilson 2002].

Social Activity Domains

CMC studies that focus on social activities tend to use descriptive or qualitative approaches, due in part to the difficulty of assigning meaningful social treatments within an experimental design. Although many social activity studies are set in a non-work context (combining intrinsic motivation and high degree of personal freedom), e.g., surveying users of online chat groups [Cornwall and Lundgren 2001], some studies are clearly set in a work context, e.g., surveying bank employees regarding the usefulness of e-mail versus FtFC for sustaining working relationships [Cummings, Butler, and Kraut 2002]. One major research theme in social activity domains addresses interpersonal relationship management involved in socialization. These activities include relational development [Chidambaram 1996; Cummings et al. 2002; Parks and Floyd 1996; Parks and Roberts 1998; Walther 1994, 1995, 1996; Walther and Burgoon 1992], individuation, de-individuation, and emergence of norms in online groups [Lea and Spears 1991; Postmes and Spears 1998; Postmes, Spears, and Lea 1999, 2000], development and outcomes of online romance [Baker 2000; Cooper and Sportolari 1997; Cornwell and Lundgren 2001; Lea and Spears 1995; Parks and Floyd 1996; van Acker 2001; Whitty and Gavin 2001], social aspects of managing teams via CMC [Sivunen and Valo 2006], and social involvement among CMC users [Kraut et al. 1998].

A second important theme explores interpersonal influence processes in CMC, including antecedents of influence [Adkins and Brashers 1995; Gueguen 2002; Kahai and Cooper 1999; Matheson and Zanna 1989], compliance-gaining goals in message production [Wilson and Zigurs 2001], leadership development [George and Sleeth 2000], and persuasive impacts of CMC [Hill and Monk 2000; Moon 1999; Te'eni et al. 2001; Wilson 2003, 2005].

Message Conveyance

A final area that has received substantial attention from CMC researchers is *message conveyance* characteristics of the communication technology. CMC message conveyance researchers have studied activities related to efficiency of communication [Lowry et al. 2005; Pendharkar and Young 2004; Pickering and King 1995; Sallis and Kassabova 2000; Sproull and Kiesler 1991], concurrency of message production [Valacich, Paranka, George, and Nunamaker 1993], broadcast capabilities [Kettinger and Grover 1997], and expansion of information accessibility [Constant, Sproull, and Kiesler 1996; Cramton 2001; Millen and Dray 2000]. As is the case in studies of task and social activities, message conveyance research has been conducted in both work and non-work contexts.

Summary: Activity Domains of CMC Research

We have identified seven activity domains that are prominent within the CMC literature. These include four task activity domains drawn from the McGrath [1984] group task circumplex model (generation, choice, negotiation, and execution), two social activity domains (socialization and influence), and a message conveyance domain. Although these activity domains are not the primary focus of the present research, we propose that studying communication technologies and contexts across the major activity domains that have been studied previously will increase the relevance of our findings to the existing CMC literature.

III. RESEARCH MODEL AND HYPOTHESES

Our literature review suggests that communication technologies, activity domains, and work/non-work contexts are distinct concepts which are related in that communication technologies are used to support activities within work and non-work contexts. We also find evidence that characteristics of communication technologies, activities, and contexts jointly determine users' perceptions regarding the technology. In some cases, effects of context appear as interactions with other factors. For example, in studying retirement task forces, Bikson and Eveland [1990] find that retirees predominate e-mail communication while current employees predominate FtFC communication, an interaction between context of use and communication technology. This observation suggests that it is important to apply a research model that addresses not only direct effects of communication technology, activity, and context, but can readily accommodate interactions among these factors.

We propose these criteria are met by extending task-technology fit (TTF) theory [Goodhue 1995] to incorporate context as well as non-task activities. In TTF theory, fit is theorized to arise from differential cognitive costs and benefits that the technology user derives from joint characteristics of technology and task requirements (see Figure 1). Fit exists when technology and task are matched in a manner that reduces cognitive effort requirements for the technology user to perform the task. Reduced cognitive effort is theorized to have further positive consequences of increased technology utilization and performance.

Empirical research generally corroborates TTF theory, finding that interactions between task characteristics and technology characteristics are important determinants of technology users' evaluations of fit [Dishaw and Strong 1999; Goodhue 1995; Goodhue and Thompson 1995; Mathieson, and Keil 1998; Vessey and Galletta 1991]. Where Goodhue [1995] included individual characteristics as part of the TTF model, however, later researchers [e.g., Dishaw and Strong 1999; Mathieson, and Keil 1998] have more narrowly focused on the direct and interactive effects of task and technology. In order to reduce complexity of the present research, our research design follows the approach of not specifically addressing individual characteristics.

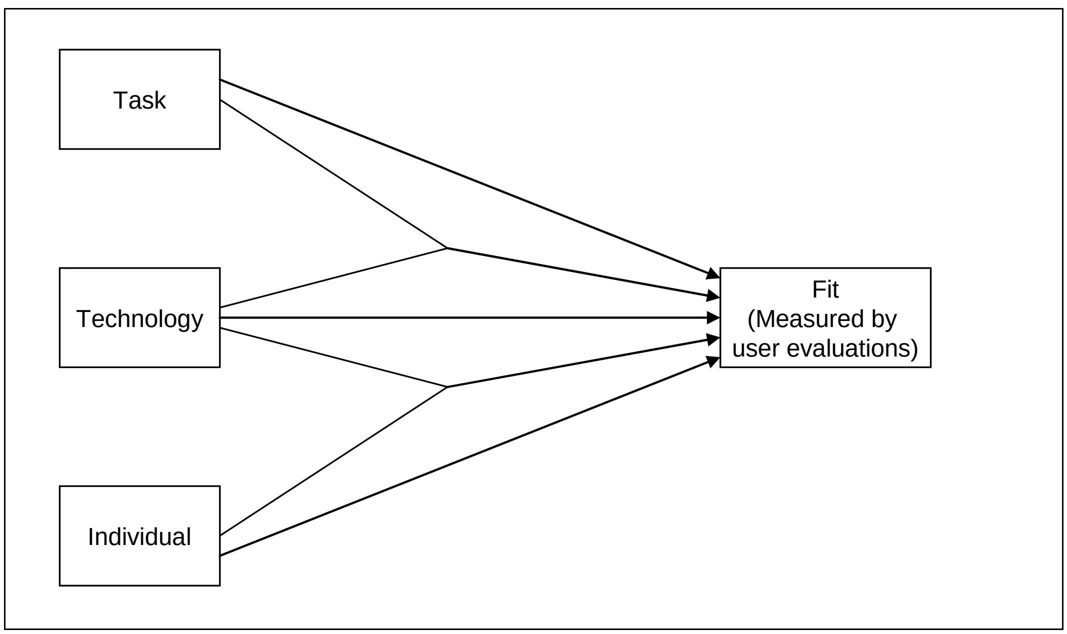

Figure 1. Task-Technology Fit Model [Goodhue 1995]

TTF theory is applied in our research to predict effects of communication technology characteristics and activity characteristics on user perceptions of fit. We modify the Goodhue [1995] model in two key ways. First, our design substitutes the term *activity* in place of task, in recognition that our research encompasses social activities and message conveyance activities as well as tasks. Second, we propose that context characteristics will present differential cognitive costs and benefits to technology users beyond those associated with technology and activity. Our research model extends TTF to include main and interactive effects of context on fit, as well as incorporating main and interactive effects of activity (task) and technology as presented in the original TTF model [Goodhue 1995]. The resulting research model is shown in Figure 2.

In the following sections, we develop hypotheses relating to each of the terms in the model, beginning with direct effects and proceeding to two-way and three-way interaction terms. Effects tested by the hypotheses are illustrated in Figure 2.

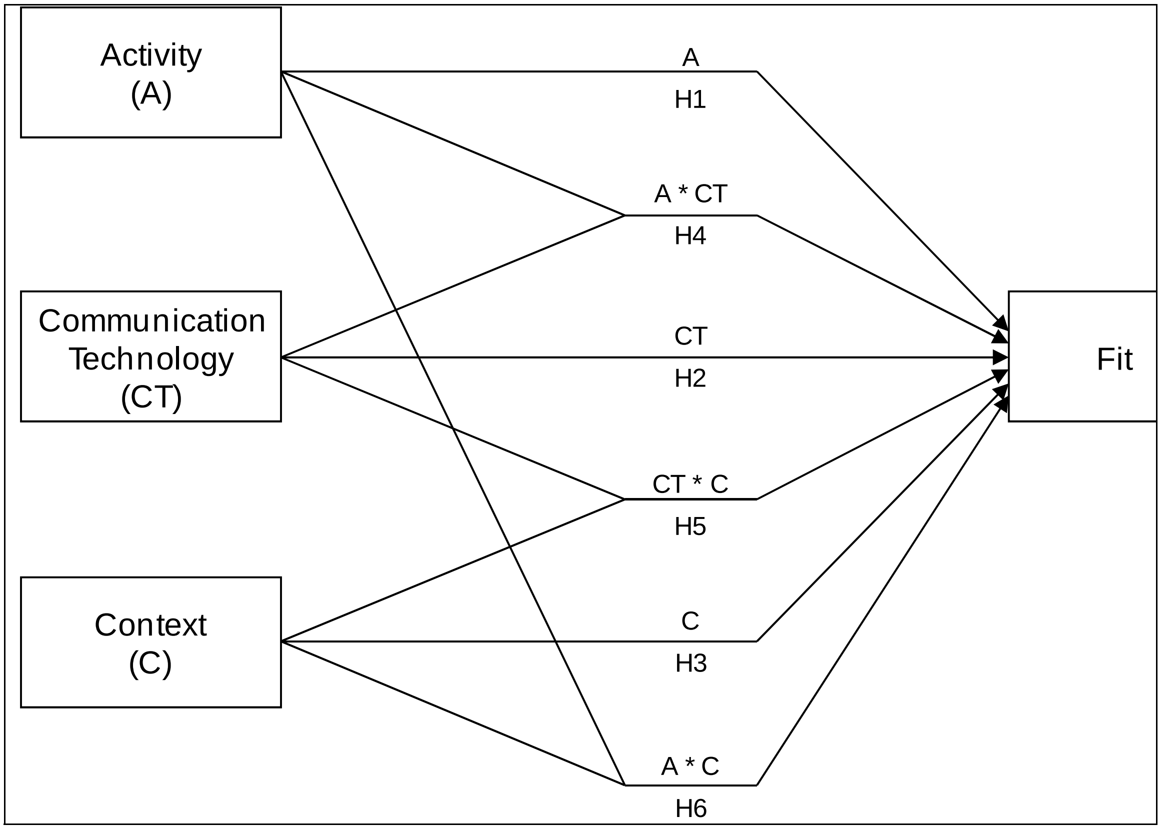

Figure 2. Research Model

As requirements for cognitive effort rise in the environment surrounding technology use, user evaluations of fit tend to decrease [Goodhue 1995]. TTF theory emphasizes interactive effects of cognitive effort associated with task and technology on user evaluations [Goodhue 1998]. Direct effects also are included in TTF research, and both task and technology are reported to have significant direct effects on evaluations [Dishaw and Strong 1999; Goodhue 1995; Goodhue and Thompson 1995; Pendharkar, Khosrowpour, and Rodger 2001; Tan et al. 1999]. Our research model follows findings of prior TTF studies in positing direct effects due to cognitive effort associated with activity (task) and technology, and proposes that cognitive effort associated with context also has direct effects within an extended TTF model.

Direct Effect of Activity

Goodhue reports that “Users engaged in more difficult, non-routine tasks gave lower evaluations for 11 of the 12 dimensions, rating their systems and services as more confusing, providing less of the right level of detail, with harder to use hardware and software, etc.” [Goodhue 1995, p. 1836]. We anticipate the seven activity domains proposed for study will present varying degrees of difficulty in terms of cognitive effort expended by subjects. Among the four task types drawn from the McGrath circumplex [McGrath 1984], requirements for cognitive effort are theorized to increase from generation to choice to negotiation task types due to increasing interdependencies with other individuals that occur as the emphasis of the tasks moves from collaboration through coordination to conflict resolution [Argote and McGrath 1993; Hollingshead et al. 1993]. The proposition that choice tasks are “harder” to perform than generation tasks has been supported by several empirical studies [e.g., Hollingshead et al. 1993; Straus 1999; Straus and McGrath 1994; Wilson et al. 1997].

User evaluations are reported to differ among non-task activities as well. For example, CMC users perceive socialization activities to be harder to perform than message conveyance [Wilson et al. 1997] and social influence activities [Wilson 2002]. These findings suggest that the activity domains proposed for the present research will range in difficulty and differentially influence user evaluations.

H1a: User evaluations of fit will vary across activity domains.

Normative Cognitive Effort Associated with Activity

Although the findings reported above offer some limited rules for ordering activities by difficulty of cognitive effort, there is no clear precedent in the literature for predicting where to position all of the activities within this range, e.g., predicting the relative difficulty of socializing activities vs. choosing activities. To address this issue we propose an independent measure of *normative cognitive effort* (NCE), representing the objective level of cognitive effort required in each activity domain.[6] NCE is conceptualized as a weighting factor developed from evaluations by judges who are independent from subjects in hypothesis testing and representing tendencies that are shared across the larger population. The independent origins of NCE can provide a conservative assessment of cognitive effort that is unrelated to communication technology, context, or individual characteristics of test subjects. We propose that NCE, as a population measure of cognitive effort, will predict the pattern of user evaluations across the activity domains under study.

H1b: Increases in the NCE of activities will decrease user evaluations of fit.

Direct Effect of Communication Technology

The informational characteristics of CMC are lower than FtFC on several dimensions. CMC provides less informational redundancy [Daft and Lengel 1986; D'Ambra, Rice, and O'Connor 1998], lower social presence [Chidambaram and Jones 1993; Rice 1992], and fewer social context cues [Sproull and Kiesler 1986]. In addition, CMC is less familiar to most people than FtFC. Individuals gain experience with FtFC beginning in infancy and develop a substantial inventory of tools and metaphors for FtFC that are used regularly and are well-understood. Adapting these tools and metaphors to CMC often is harder than expected [Wilson 2002], and using CMC effectively can require experimentation and new learning to overcome habituation [Gefen 2003] or natural orientation toward FtFC [Kock 2004]. Although there is evidence that CMC is better than FtFC in performing certain activities, such as idea generation [Dennis and Gallupe 1993], research suggests FtFC is more effective overall [Wilson 2002]. We propose that the higher informational characteristics and familiarity of FtFC will act to reduce cognitive effort and increase perception of fit for FtFC.

H2: User evaluations of fit will be higher overall for FtFC than CMC.

Direct Effect of Context

In a work context, communication frequently is characterized by uncertainty and equivocality [Brashers 2001; Daft and Lengel 1986; Daft, Lengel, and Trevino 1987], and workers have relatively little personal control over the timing, partners, or topics of communication. This suggests communication in a work context will entail cognitive effort that is both substantial and unavoidable. In contrast, individuals in a non-work context tend to conduct activities that are personally satisfying [Parker 1983]. They are free to choose communication timing, partners, and topics. Prior TTF research finds that evaluations of fit are lower where the environment surrounding technology use is seen as more difficult [Goodhue 1995]. We propose that unavoidable cognitive effort arising from uncertainty and equivocality in a work context will increase cognitive effort, resulting in reduced perception of fit.

H3: User evaluations of fit in a non-work context will be greater than in a work context.

Interaction of Activity and Communication Technology

Two types of interaction have been reported previously between activity and communication technology. Message-conveyance activities are considered to be particularly well supported by CMC due to "first-level efficiency effects" that structurally reduce cognitive effort [Sproull and Kiesler 1991, p. 21]. Message-conveyance includes a range of simple transmission-oriented activities such as delivering messages quickly, supporting asynchronous communication (i.e., messages that can be retrieved at a later time), and broadcasting messages to multiple receivers [Kettinger and Grover 1997; Pickering and King 1995; Sallis and Kassabova 2000; Valacich, Paranka, George, and Nunamaker 1993]. Based on prior research findings, we anticipate CMC will have greater fit with message-conveyance than other activities across work and non-work contexts.

H4a: User evaluations of fit of CMC for message-conveyance activities will be greater than for other activities.

Another reported interaction is specific to task activities. Argote and McGrath [1993] theorized that CMC provides cognitive cues that are sufficient to enable performance of generate tasks, which require only transmission of simple facts, beliefs, and ideas, but are not sufficient to readily support choose tasks, which require interdependent development of consensus, or negotiate tasks, which require resolution of conflicts [Hollingshead et al. 1993]. Subsequent empirical studies support the proposition that implicit cognitive requirements are higher for choice and negotiation tasks than for generation tasks [Straus 1999; Wilson 2002]. We anticipate CMC will be viewed as a better fit for generation tasks than other task activities.

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[6] A complete description of development and testing of the NCE measure is presented in the Research Methods section later in the paper.

H4b: User evaluations of fit of CMC with generation tasks will be greater than for other task activities.

We also anticipate NCE will predict the pattern of interactions associated with activity domains. Both interactions we have hypothesized between activity and communication technology are predicated on differentials in cognitive costs and benefits to the technology user. CMC obstructs transmission of some communication cues, e.g., nonverbal cues, which can make discussions harder to regulate and more difficult to understand, thereby restricting the flow of information [McGrath and Hollingshead 1993]. Because activities characterized by high cognitive difficulty tend to have high informational requirements [Galbraith 1977], restricted information flows will disproportionately burden CMC users in activity domains where there is above-average need to understand "values, attitudes, emotions, expectations, commitments, and so on" [McGrath and Hollingshead 1993, p. 81]. Based on this assessment, we anticipate that CMC will receive lower evaluations of fit relative to FtFC for high-NCE activities than low-NCE activities.

H4c: Increase in NCE will predict decrease in fit evaluation of CMC relative to FtFC.

Interaction of Communication Technology and Context

Interaction between communication technology and context has been reported on a number of measures, including mode of participation [Bikson and Eveland 1990], user evaluations [Walsh and Bayma 2001; Wilson 2002; Zack and McKenney 1995], and performance outcomes [Dennis et al. 2001; Murthy and Kerr 2000; Straus 1999; Straus and McGrath 1994; Sussman and Sproull 1999; Tan et al. 1999; Zack and McKenney 1995]. Although we did not find any research explicitly addressing both work and non-work contexts, these findings imply that interactions between communication technology and contextual factors occur frequently. As previously discussed, cognitive effort arising from uncertainty and equivocality cannot be easily avoided in a work context, and CMC tends to restrict information flow. We propose the combination of these factors will increase the cognitive effort required of individuals using CMC in a work context on average, with the result of reducing their evaluations of fit.

H5: User evaluations of CMC fit in non-work context will be greater than in work context.

Interaction of Activity and Context

We have argued previously that the activity domains proposed for study vary in perceived difficulty and that work context tends to increase perception of difficulty. We propose that interaction will occur between activity domain and context arising from the combined cognitive effort that accrues from these factors. We further anticipate the pattern of interaction will be predicted by NCE.

H6a: User evaluations of fit of CMC and FtFC for difficult activities in work context will be lower than for other activities and for overall activities in non-work context.

H6b: Increase in NCE will predict decrease in users' evaluation of fit for activities in CMC relative to FtFC.

Interaction of Activity, Communication Technology, and Context

The research model contains a term denoting three-way interaction among activity, context, and communication technology. It is important in a factorial model to analyze and report all possible interactions [Tabachnick and Fidel 1989]. However, there is little precedent for identifying potential sources of three-way interactivity in our research model *a priori.* Therefore, we plan to conduct follow-up analysis to explore effects, if any, that appear through three-way interaction among the independent variables.

IV. RESEARCH METHOD AND RESULTS

Overview

The research encompasses two studies. In Study 1, items were identified to represent the content of each activity domain. These *activity items* were evaluated by judges to assess their relevance in both CMC and FtFC and across work and non-work contexts. In addition, subjects evaluated the uncertainty, equivocality, and frequency of activity items to develop NCE ratings for each activity domain. Study 2 measures perception of fit for each combination of activity item and communication technology in both work and non-work contexts in order to test the hypotheses presented earlier.

E-mail is the dominant form of CMC in current use [Caslon 2002]. For this reason we chose to implement e-mail in preference to alternative forms of text-based CMC technology, such as threaded discussion lists, instant messaging, online chat, or computer conferencing.

Study 1: Development of Activity and NCE Measures

As discussed previously, fit is a cognitive construct that is theorized to arise from differential cognitive costs and benefits that the technology user derives from joint characteristics of technology and task requirements [Goodhue 1995]. In addition, fit is theorized to contribute to performance outcomes [Goodhue and Thompson 1995]. Both relationships have been used to measure fit. Performance measures have been used to imply the existence of fit, such as speed and accuracy performance in subjects' responses to questions based upon various display modes [Vessey and Galletta 1991]. However, perceptual measures are more commonly applied. For example, Goodhue [1995] identifies 12 dimensions of fit assessment that can be captured as perceptual measures, and Dishaw and Strong [1999] calculate fit measures from programmers' perceptions of task characteristics and tool functionalities. Goodhue proposes that fit is "most appropriately measured by assessing the user's beliefs of how satisfactorily systems meet task needs, regardless of how the user might feel about those systems" [1998, p. 112]. These measurements should be anchored to specific aspects of the task or operational needs rather than being overly generalized, and they should be directed toward systems that the individual has actually used [Goodhue and Thompson 1995].

We chose to measure fit by assessing users' *perceived effectiveness* of the communication technology for performing items that represent the content of each activity domain. We anchored measures to specific activities and only included subjects who had experience in using the systems under study. Using this approach, fit between CMC technology and a specific activity, e.g., resolving differences of opinion, might be assessed in the work context of team-based software development through collecting users' scaled responses to the question: *Based upon your experiences in team-based software development projects, how effective or ineffective do you believe CMC technology is for resolving differences of opinion among team members in this setting?*

Table 3. Evaluation Instructions and Measurement Scales Used in Study 1

Judging Group ***Measured Construct***	**Judging Instruction**	**Scale**
Non-work context judges *Perceived effectiveness of CMC*	Effectiveness is defined as "producing the desired result." For each of the following activities, circle your assessment of how effective or ineffective you believe computer-mediated communication is for low-stress communication in your classes and with friends, family, and acquaintances.	5-position scale marked on 1 and 5: 1 = Very Ineffective 5 = Very Effective
Non-work context judges *Perceived effectiveness of FtFC*	Effectiveness is defined as "producing the desired result." For each of the following activities, circle your assessment of how effective or ineffective you believe face-to-face communication is for low-stress communication in your classes and with friends, family, and acquaintances.	5-position scale marked on 1 and 5: 1 = Very Ineffective 5 = Very Effective
Work context judges *Perceived effectiveness of CMC*	Effectiveness is defined as "producing the desired result." For each of the following activities, circle your assessment of how effective or ineffective you believe computer-mediated communication is for communicating with team members in a high-stress software development project.	5-position scale marked on 1 and 5: 1 = Very Ineffective 5 = Very Effective
Work context judges *Perceived effectiveness of FtFC*	Effectiveness is defined as "producing the desired result." For each of the following activities, circle your assessment of how effective or ineffective you believe face-to-face communication is for communicating with team members in a high-stress software development project.	5-position scale marked on 1 and 5: 1 = Very Ineffective 5 = Very Effective
All judges *Uncertainty*	Uncertainty is defined as "not having enough information needed to conduct a particular activity." For each of the following activities, circle your assessment of how uncertain or certain you are in conducting the activity, based on your day-to-day experiences.	5-position scale marked on 1 and 5: 1 = Very Uncertain 5 = Very Certain
All judges *Equivocality*	Equivocality is defined as "being ambiguous or having multiple, conflicting interpretations; not clear-cut." For each of the following activities, circle your assessment of how equivocal or clear-cut you consider the activity to be, based on your day-to-day experiences.	5-position scale marked on 1 and 5: 1 = Very Equivocal 5 = Very Clear-cut
All judges *Frequency*	Frequency refers to how often you conduct a particular activity. For each of the following activities, circle your assessment of how infrequently or frequently you conduct the activity in your day-to-day experiences.	5-position scale marked on 1 and 5: 1 = Very Infrequently 5 = Very Frequently

Perceived effectiveness captures users' beliefs regarding the *instrumentality* of a technology in performing an activity, i.e., whether the technology provides an effective instrument to achieve the desired result for a given purpose. Instrumentality is a central concept underlying TTF theory [Goodhue 1995; Goodhue 1998], and measurement of fit through perceptions regarding instrumentality is supported by Goodhue, who writes, "if users utilize a technology because of its instrumentality in their task, it is reasonable to believe they are capable of evaluating that technology's [fit] from their personal experience" [1995, p. 1830]. Perceived effectiveness measures are prominent in CMC research [Fjermestad 2004]. Thus, we anticipate that our findings will be relevant both to prior TTF studies and to much of the existing CMC literature.

Activity Domains

We drew upon theoretical definitions and prior empirical research to develop items for each of the seven activity domains. *Convey* activity items address characteristics of message content and delivery, including efficiency of communication [Sproull and Kiesler 1991], concurrency of message production [Valacich, Paranka, George, and Nunamaker 1993], broadcast capabilities [Kettinger and Grover 1997], and expansion of information accessibility [Constant, Sproull, and Kiesler 1996; Cramton 2001; Millen and Dray 2000]. *Socialize* activity items focus on initiating new social relationships [Cummings et al. 2002; Parks and Floyd 1996] and maintaining existing social relationships [Kraut et al. 1998, Postmes et al. 2000]. *Influence* activity items include aspects of motivation [Adkins and Brashers 1995], persuasion [Moon 1999; Wilson 2005], and compliance-gaining [Wilson and Zigurs 2001]. Task activity items were drawn from McGrath's [1984] theoretical definitions of each task category. *Generate* activity items include development of ideas and plans, brainstorming, and other creative actions. *Choose* activity items address selection among alternatives both where there is an objective correct choice and where the choice must be made by group preference. *Negotiate* activity items emphasize resolution of group members' viewpoints or policies as well as conflicts of interest. *Execute* activity items focus on aspects of group performance.[7] A minimum of eight activity items were developed for each activity domain.

The resulting 57-item instrument was administered in Study 1 for item judging by 62 seniors nearing the end of their capstone information systems course at a large U.S. university. Participants could receive extra course credit by participating in item judging or by performing a comparable alternative task which involved questionnaire development. These participants were experienced both in e-mail use and in multiple, semester-long, team-based software development projects that are representative of a work context. Thus, they possessed the essential skills for participating fully in this research setting. Judges were assigned randomly to conditions in which half evaluated the complete set of activity items for a non-work context and half for a work context using instructions shown in Table 3. They assessed perceived effectiveness of both CMC and FtFC for performing each activity item. Statistical power analysis of this design indicates power of .62 in finding a medium effect size (r = .25, α = .05) and .87 in finding a large effect size (r = .40, α = .05). From these data, difference scores were calculated between CMC and FtFC on each item. Interrater reliability for the difference measures was calculated in SPSS using intraclass correlation with Spearman-Brown correction for multiple judges [MacLennan 1993]. The strategy driving this procedure was to identify and remove items that are not reliable measures of differences between communication technologies within each activity domain.[8] Five activity items were deleted based on low interrater reliability scores, i.e., where agreement among the subjects about the relative difference in the technologies was lacking. Interrater reliability is .77 or above for the 52 retained activity items, which are listed in Table 4 by activity domain.

Normative Cognitive Effort

In the second part of Study 1 we developed the NCE measure to predict normative cognitive effort requirements for each activity domain. Cognitive effort typically is measured through the affected individual's perception of mental difficulty associated with an activity [Kock 2004]. In order to assess cognitive effort normatively, however, it is essential that NCE measurements be unrelated to characteristics of the individuals, communication technologies, and contexts that are employed in Study 2. We also consider it desirable that NCE be anchored by specific contributors to mental difficulty that are important in the CMC and TTF literatures. We identified three perceptual factors for this purpose that are commonly associated with cognitive effort: uncertainty, equivocality, and frequency.

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[7] In addition to performance tasks, McGrath's execute category includes contests, described as "tasks for which the unit of focus, the group, is in competition with an opponent, and enemy, and performance results will be interpreted in terms of a winner and a loser, with pay-offs in those terms as well" (McGrath 1984, p. 65). Aggressive competitions of this type are outside the scope of the academic setting of the present research, so no contest-related items were used.

[8] Because this study is predicated upon testing factors that are directly relevant to existing CMC research, our primary objective was to achieve content validity by populating each activity domain with items that adequately represent the universe of content for each category (Chronbach 1971). The activity domains are drawn *prima facie* from literatures that contain overlapping content, e.g., influencing and negotiating, and are not intended to be mutually exclusive categories. Thus, we do not attempt to achieve discriminant validity by the process of dropping items that cross-load with other factors as this action would reduce representativeness of the items to the underlying activity domain.

Table 4. Retained Activity Items and Evaluation Statistics from Study 1

Activity Domain*	Activity Items	
Convey Eff. ICC = .87 NCE ICC = .84 NCE *z* = -.20	Communicating information accurately Communicating information completely Communicating information quickly Communicating last-minute changes in a task Delivering a message to several people	Making sure that everyone to whom a message is intended receives it Making sure that people don't misinterpret your message Saying everything that you intended to say
Socialize Eff. ICC = .82 NCE ICC = .79 NCE *z* = .09	Arranging social activities Exchanging information of a personal nature Getting acquainted with people Getting to know people better	Kidding around Letting someone know you are upset Telling jokes
Influence Eff. ICC = .80 NCE ICC = .94 NCE *z* = .69	Getting someone to do a favor for you Influencing someone to get what you want Motivating someone to do their part in a group task Persuading others by offering rewards	Persuading others by threatening negative consequences Using a logical argument to get what you want Using an emotional argument to get what you want
Generate Eff. ICC = .77 NCE ICC = .74 NCE *z* = -.51	Generating ideas Generating plans Identifying shared goals Planning a meeting agenda	Planning what tasks need to be done Planning when tasks need to be completed Planning who will do specific tasks
Choose Eff. ICC = .82 NCE ICC = .97 NCE *z* = -.11	Choosing when all of the alternatives seem about the same Choosing when none of the alternatives seem very good Choosing when the best alternative is not clear	Choosing when the best alternative seems obvious Making complex decisions Making difficult decisions Making easy decisions Making simple decisions
Negotiate Eff. ICC = .85 NCE ICC = .82 NCE *z* = .22	Negotiating how much to pay for something Negotiating how to do something Negotiating the appearance of some product or deliverable Negotiating who will be responsible for something	Negotiating who will do specific tasks Negotiating who will pay for something Resolving conflicts Resolving differences of opinion
Execute Eff. ICC = .88 NCE ICC = .93 NCE *z* = -.17	Delivering a finished report Developing a presentation with other people Discussing what artwork to use in a group task	Editing a report developed with other people Improving a group presentation Revising the requirements for a task Writing a report with other people

* Eff. ICC = Intraclass correlation coefficients (interrater reliability) for effectiveness difference scores (Eff. ICC); NCE ICC = Intraclass correlation coefficients for NCE scores; NCE *z* = NCE *z*-scores for each activity domain

Uncertainty of an activity increases cognitive effort by requiring individuals to choose among competing heuristics rather than implement a straightforward decision strategy [Morgan and Henrion 1990] and by placing a premium on acquiring additional information in attempts to reduce uncertainty [Galbraith 1977; Thompson 1967]. *Equivocality* or ambiguity of an activity raises cognitive effort through the need to register the "multiple and conflicting interpretations about an organizational situation" [Daft and Lengel 1986, p. 556] and subsequently transform them to a less-equivocal state [Weick 1969]. Numerous CMC studies address uncertainty and equivocality as sources of cognitive effort through the lens of media richness theory (MRT) [Daft and Lengel 1986; Daft et al. 1987]. MRT predicts that lean media, such as CMC, will be difficult to use to reduce uncertainty and resolve equivocality. However, empirical support for this prediction has been mixed, prompting CMC researchers to develop new perspectives and research designs for investigating MRT [Kahai and Cooper 2003]. The present research does not utilize MRT, but we anticipate that incorporating uncertainty and equivocality dimensions will increase relevance of the NCE measure to CMC studies that are based upon MRT and that our findings may be useful in explaining some of the equivocalities that characterize the MRT literature.

Frequency of performing an activity tends to reduce cognitive effort through practice effects [Anderson 1985] as individuals learn to correctly categorize patterns [deGroot 1965] and build more effective problem representations [Lesgold et al. 1988]. Goodhue and Thompson's [1995] findings from empirical testing of TTF theory suggest that cognitive effort of workers increases substantially where IT is used to perform novel and non-routine tasks (i.e., tasks of low frequency). Thus, relevance to the TTF literature will be enhanced by incorporating a frequency dimension within the NCE measure.

All judges evaluated each of the activities presented in Table 4 using the instructions and scales for uncertainty, equivocality, and frequency described in Table 3. These factors are *formative* of cognitive effort, meaning that the measurement items make distinct contributions to the cognitive effort construct and are not assumed to be correlated as would be the case for reflective measures [Chin 1998; Gefen, Straub, and Boudreau 2000; Petter, Straub, and Rai 2007].

NCE measures for each activity item were calculated as the averaged aggregate of uncertainty, equivocality, and frequency ratings. Interrater reliability is .74 or above for NCE within each activity domain. NCE *z*-scores are calculated by averaging the NCE item scores in each activity domain and then standardizing these to the grand mean for all NCE item scores. Interrater reliability across the seven activity domain *z*-scores is .92. Interrater reliability and NCE *z*-scores for each activity domain are presented in Table 4.

Study 2: Testing Subjects in Work and Non-Work Contexts

Study 2 is a quasi-experiment with two context treatments conducted over a 15-week period. Participation in the study was integrated into the schedule and syllabus for three undergraduate Information Systems courses at a mid-sized U.S. university. The students were enrolled in three courses, each taught by a different instructor. Students were told at the beginning of the course that "research in interpersonal communication patterns" was being conducted during the semester, and that they would have the option to opt out of participation at the time of data collection. Data collection was conducted through a post-test questionnaire administered during a final class session. We propose that the significant length of the treatment period in this design aids in minimizing erratic effects relating to variety of contextual factors, such as weather conditions and events in the news, and variability between contexts in which communication technologies were used. All 150 students who were enrolled during the final week of the course meetings opted to complete the questionnaire. Statistical power analysis of this design indicates power of .85 in finding a medium effect size ($r = .25$, $\alpha = .05$) and .97 in finding a large effect size ($r = .40$, $\alpha = .05$).

The second phase of our research was designed to compare evaluations by subjects in work vs. non-work contexts. Although CMC originally was used almost exclusively in a work context, most individuals' first experience with CMC now occurs in a non-work context, such as communicating via e-mail with friends and family. At some later time, perhaps in a college course or a business environment, CMC will be used in a work context, such as communicating with at-distance members of a project team. For this reason, we anticipated virtually all our subjects in Study 2 would have experience in use of CMC in a non-work context.

We considered using a repeated measures design to implement this strategy. However, we were concerned about potential for confounding by (1) learning effects among subjects completing the same survey more than once and (2) divergent environmental factors between treatments such as seasonal differences, technology changes, and world events. We decided instead to implement a cross-sectional design in which we would simultaneously observe subjects in separate work and non-work contexts.

Subjects in the first context condition were 60 students enrolled in a survey of information systems course. The course is among the first taken by information systems majors. Students in this course had not yet worked in team-based software development, which is a major component of the other two courses. During the study, subjects used e-mail at their own volition for activities unrelated to the course and for course activities if they wished, e.g., corresponding with the instructor or obtaining information about assignments. They were required to reply to the instructor's e-mail once during the beginning of the study to ensure that they knew how to use e-mail and had an active e-mail account. There were no other requirements during the study for subjects in this context to send or read e-mail. This condition was designed to represent a non-work context, where communication is intrinsically motivated and individuals have a high degree of personal freedom to choose their partners, topics, and timing in communication.

Subjects in the second context condition were 56 students in a third-generation language (3GL) programming course and 34 students in a database course. In each course, self-managed teams of three to five members were responsible for developing substantial software projects accounting for 20 percent of course credit. Each team was made up of members from different course sections, making it inherently difficult to arrange times for face-to-face meetings. The need to coordinate their projects promoted complex and recurring interactions among team members. Many of the activities were novel to subjects, and the overall project requirements were designed to be difficult to complete in their entirety within the allocated time period, thus creating meaningful obligations among team members. This condition was designed to represent a work context, where individuals are substantially constrained in choosing the topics, times, and partners in communication. As with the non-work context condition, subjects were required to reply to the instructor's e-mail once during the beginning of the study to ensure that they knew how to use e-mail and had an active e-mail account. There were no other requirements during the study for subjects in the work context to send or read e-mail.

At the end of the study a post-test was administered to all subjects, using a pencil and paper questionnaire. The post-test included demographic and descriptive questions (see Table 5) and the activity instrument. Activity items were presented in randomized order. In the non-work context, subjects rated e-mail and FtFC for all activity items in response to this question (e-mail version shown):

Based on your experiences with e-mail for general communication this semester, how effective do you feel e-mail is for the following activities?

In the work context, subjects rated e-mail and FtFC for all activity items in response to this question (FtFC version shown):

Based on your experiences with face-to-face communication in your project team this semester, how effective do you feel face-to-face communication is for the following activities?

Ratings were collected using five-position scales with endpoints marked as 1 = Very Ineffective and 5 = Very Effective.

Table 5. Subjects' Descriptive Statistics

Variable	**Study 1 Item Judges**	**Study 2**	
		Non-Work Context	**Work context**
N	62	60	90
Age	24.7 (6.01)	21.5 (2.5)	22.4 (3.8)
Gender	69% M, 31% F	65% M, 35% F	67% M, 33% F
Number of years used e-mail	5.0 (1.7)	3.0 (1.8)	3.7 (1.5)
Number of e-mail messages sent per week	20.7 (22.2)	10.5 (12.8)	Overall: 14.2 (17.6) To team: 2.4 (3.9)
Number of e-mail messages received per week	43.8 (44.6)	13.8 (15.2)	Overall: 18.2 (18.4) From team: 6.5 (7.2)
Previous student group projects	11.4 (6.8)	3.4 (3.1)	6.1 (3.6)

The 15-week duration and field setting of the research provided an opportunity for subjects to participate in conditions representing a natural variety of contextual factors beyond the controlled treatment context and for natural variability to occur between contexts. For example, subjects had opportunity to communicate regarding a wide variety of topics and in variable settings, including transitions between home and university computer labs.

Subjects were not restricted to using a particular e-mail application. However, 93 percent reported that they primarily used QualComm's Eudora Pro e-mail software. This software was installed in university computer labs and was available at no cost for installation on students' home computers. Eudora Pro is similar to other mainstream e-mail clients, e.g., Microsoft Outlook Express. It provides asynchronous text messaging, supports file attachments, and features a graphical user interface conforming to Microsoft Windows standards.

Threats to Validity

In applying quasi-experimental designs to conduct research across academic courses there is potential for systematic differences to occur between sub-populations, as subjects cannot be randomly assigned to treatment conditions. In the present research, treatment conditions were implemented as part of the required course sequence for information systems majors. For this reason we anticipated that the treatment groups would constitute a homogenous population and have similar characteristics in most respects. One exception is that the non-work context was implemented in a second-year course and the work context was implemented in two third-year courses. Thus, we anticipated that factors related to age and academic experience would differ between conditions. It also is not possible *a priori* to control effects of spurious factors that may vary systematically between the conditions, such as course content and course instructor communication style. To overcome these limitations, we planned to conduct *post hoc* tests as a part of data screening and validation to assess the extent of spurious effects. Results of this testing are reported in the next section.

Study 2 Results

Descriptive data from Study 2 are shown in Table 6 and summarized in Figure 3. Slight to moderate negative skew appeared in approximately half the scales and corrective transformations were calculated. These transformations improved skewness somewhat overall, but were accompanied by emergence of negative kurtosis in several scales. Since transformation did not result in overall improvement, the raw data were used for analysis as recommended by Tabachnick and Fidell [1989]. No extreme multivariate outliers were found in the data. Activity domain alpha reliabilities averaged .75, for e-mail and .76 for FtFC.

Table 6. Study 2 Activity Scale Reliability, Means, and Standard Deviations*

Scale	Communication Technology	Scale Alpha	Non-work context	Work context		
				Combined	3GL	Database
Convey	E-mail	.66	4.10 (.56)	3.82 (.60)	3.85 (.57)	3.78 (.66)
	FtFC	.72	4.04 (.56)	4.13 (.58)	4.11 (.55)	4.17 (.63)
Socialize	E-mail	.67	3.69 (.67)	3.21 (.76)	3.27 (.76)	3.11 (.76)
	FtFC	.72	4.54 (.45)	4.69 (.36)	4.73 (.32)	4.62 (.42)
Influence	E-mail	.71	3.33 (.63)	3.00 (.71)	3.06 (.77)	2.90 (.60)
	FtFC	.79	4.52 (.42)	4.52 (.47)	4.51 (.46)	4.54 (.48)
Generate	E-mail	.76	3.93 (.57)	3.73 (.75)	3.77 (.74)	3.66 (.77)
	FtFC	.81	4.39 (.43)	4.57 (.42)	4.60 (.36)	4.51 (.51)
Choose	E-mail	.75	3.57 (.57)	2.95 (.72)	3.01 (.74)	2.85 (.69)
	FtFC	.74	4.25 (.48)	4.60 (.39)	4.61 (.34)	4.59 (.45)
Negotiate	E-mail	.83	3.32 (.61)	2.91 (.83)	2.92 (.87)	2.88 (.78)
	FtFC	.84	4.45 (.42)	4.65 (.39)	4.67 (.38)	4.63 (.41)
Execute	E-mail	.85	3.50 (.71)	2.94 (.96)	2.96 (.87)	2.91 (.98)
	FtFC	.72	4.39 (.49)	4.65 (.45)	4.71 (.38)	4.56 (.54)
Number of cases		150	60	90	56	34

* Standard deviations are shown in parentheses.

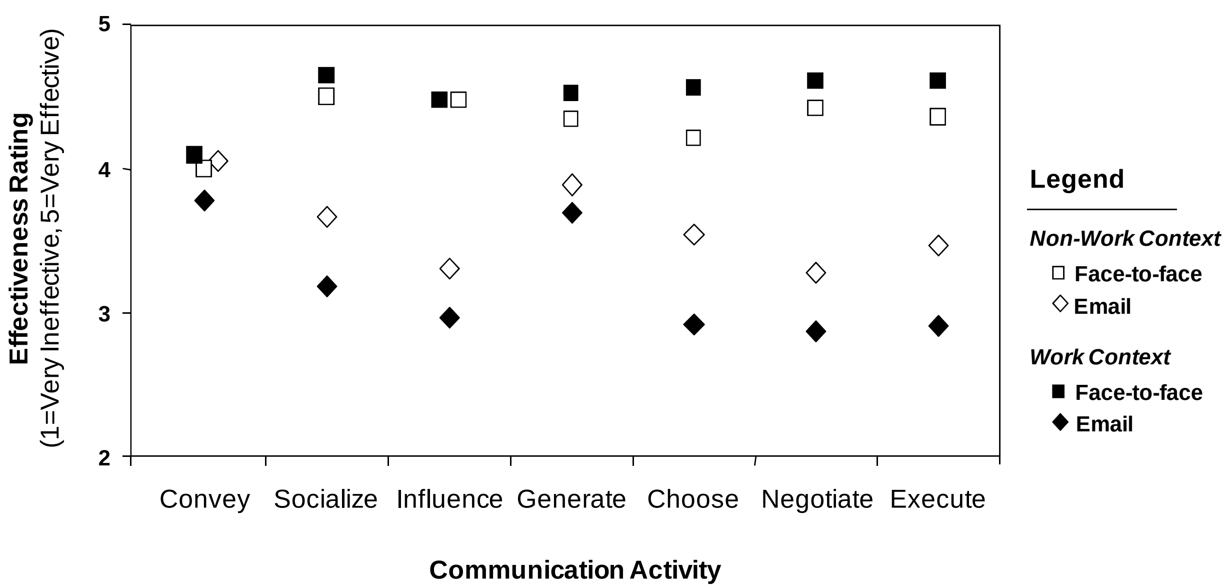

Figure 3. Study 2 User Evaluations of Fit by Activity and Context

Data from the two subgroups within the work context treatment (3GL and database) were analyzed *post hoc* to ascertain whether these constitute a homogeneous population and to test for effects related to team membership that could compromise analysis at the individual level. No significant differences were found between the two subgroups or among project teams on the descriptive data or measures in any of the activity domains, thus subsequent analysis pooled data from both work context groups. These findings suggest that the research design is robust to differences between course settings, such as instructor and course topic, and support the decision to conduct subsequent analysis at the individual level.

Analysis of the descriptive data confirmed two anticipated differences between contexts. First, the work context subjects had used e-mail significantly longer than the non-work context subjects (3.7 vs. 3.0 years, $t = 2.49$, $p = .024$). Second, the work context subjects had participated in more student group projects (6.1 vs. 3.4, $t = 4.90$, $p < .0001$). Although we had expected to also find age differences, the analysis showed that these were not significant relative to variance in the subject pool. Data screening revealed no other differences between context groups, suggesting they were drawn from a population that is homogeneous except for level of experience, a difference that is appropriate to our research design of observing subjects prior to and following immersion in a work context. Although effects of spurious factors cannot be ruled out completely in a quasi-experimental research design, results of the *post hoc* analysis suggest that effects found between groups arise from differences in treatment conditions rather than factors relating to group membership.

Hypothesis Tests

Hypothesis testing that analyzes Study 2 data exclusively was conducted using mixed between/within-subjects ANOVA. In order to identify the source of variance in ambiguous situations, e.g., where direct effects are subordinated by interactions, we followed up ANOVA with planned contrasts and other appropriate tests [Tabachnick and Fidell, 1989]. Results are shown in Tables 7 and 8.

Table 7. Summarized Results of ANOVA of Study 2 Data

Source of Variance	df	*F*	Sig.	Partial *Eta*^{2}
Activity	5	43.57	<.0001	0.65
Technology	1	387.11	<.0001	0.72
Context	1	3.98	.048	0.03
Technology x Activity	5	67.91	<.0001	0.74
Activity x Context	5	2.13	.054	0.08
Technology x Context	1	31.76	<.0001	0.18
Technology x Context x Activity	5	6.27	<.0001	0.21

Table 8. Homogeneous Subsets of Study 2 Ratings

Communication Technology	Activity domain	Scale Means				
		Subset 1	Subset 2	Subset 3	Subset 4	Subset 5
E-mail	Convey	3.93				
	Generate		3.81			
	Socialize			3.40		
	Choose				3.20	
	Execute					3.17
	Influence					3.13
	Negotiate					3.07
FtFC	Socialize	4.64				
	Negotiate		4.57			
	Generate		4.56			
	Execute		4.55			
	Influence		4.52			
	Choose			4.45		
	Convey				4.00	

Activity

Hypothesis 1a proposes that activity has direct effects on evaluation of fit. This is supported by ANOVA of the data from Study 2 ($F_{6,144}$ = 43.57, p < .0001). Hypothesis 1b proposes that NCE will predict user evaluations of activity. Effect size for the activity term is reduced from .66 in the unweighted data to .54 in the weighted data, indicating that NCE significantly predicts user evaluations of activity ($F_{6,144}$ = 18.01, p < .0001). These results support Hypothesis 1b.

Communication Technology

Hypothesis 2 proposes that FtFC will receive higher evaluation of fit than CMC. ANOVA results support Hypothesis 2a (e-mail mean rating = 3.45, FtFC mean rating = 4.45, $F_{1,149}$ = 387.11, p < .0001). This finding corroborates other CMC studies where user evaluation measures are reported [Daly, 1993; Gallupe and McKeen, 1990; Wilson, 2002].

Context

Hypothesis 3 proposes that user evaluations of fit will be higher in a non-work context than in a work context. ANOVA results support Hypothesis 3 (non-work context mean rating = 4.00, work context mean rating = 3.88, $F_{1,149}$ = 3.98, p = .048).

Interaction of Activity and Communication Technology

Hypotheses 4a and 4b test two previously-reported areas of interaction between activity and communication technology. ANOVA confirmed that significant interaction was present, so follow-up analyses were conducted to test mean differences among the activity domains (see Table 8). The results support both Hypothesis 4a and 4b. E-mail is rated higher for convey than all other activities, corroborating prior findings regarding first-level efficiency effects of CMC [Sproull and Kiesler, 1991]. E-mail also is rated higher for generate tasks than other task activities. For both e-mail and FtFC, distinct hierarchies of fit emerged among activities. E-mail ratings were highest for convey, followed by generate, socialize, choose, and the grouping of execute, influence, and negotiate. Socialize was rated highest in FtFC, followed by the grouping of negotiate, generate, execute and influence, then followed by choose and convey.

Hypothesis 4c proposes that NCE can predict interactions between activity and communication technology. To test this hypothesis, difference scores were calculated by subtracting each subject's mean e-mail scores from FtFC scores for each activity domain and using ANOVA to compare these to difference scores calculated from the NCE-weighted data. Effect size for the activity term was reduced from .72 in the unweighted data to .64 in the weighted data ($F_{6,144}$ = 28.56, p < .0001), supporting Hypothesis 4c. In order to identify the source of this effect, ANOVA was used to compare the NCE-weighted and unweighted data separately for e-mail and FtFC. Effect size for the activity term in e-mail was reduced from .77 in the unweighted data to .66 in the weighted data ($F_{6,144}$ = 35.63, p < .0001). Weighted data did not produce a reduction in effect size for the FtFC activity term. This finding indicates the source of interaction between activity and communication technology is poor fit of e-mail with difficult activities.

Interaction of Communication Technology and Context

Hypothesis 5 proposes that CMC will be evaluated higher overall by subjects in a non-work context than in a work context. ANOVA showed significant interaction between communication technology and context, and follow-up analyses were conducted to identify the source of the interaction. These find e-mail is rated higher in a non-work context (non-work context mean = 3.64 vs. work context mean = 3.22, t = 4.62, p < .0001) and FtFC is rated higher in a work context (non-work context mean = 3.37 vs. work context mean = 3.55, t = -2.98, p = .003). These results support Hypothesis 5 and corroborate prior findings of researchers studying TTF [Goodhue, 1995; Goodhue and Thompson, 1995] and low- and high-interaction contexts [Wilson, 2002].

Interaction of Activity and Context

Hypothesis 6a proposes that activity and context interact. ANOVA results did not support this hypothesis. Hypothesis 6b further proposes that this interaction will be predicted by NCE, but in the absence of an interaction the hypothesis is moot.

Interaction of Activity, Communication Technology, and Context

Along with hypothesis testing, we also tested for presence of three-way interaction among activity, context, and communication technology. ANOVA showed a significant interaction ($F_{1,149}$ = 4.54, p < .0001). Follow-up analysis indicates the interaction is principally associated with convey and choose activities. The predominant rating pattern across activities (see Figure 3) is high-to-low rating order of FtFC in the work context, FtFC in the non-work context, e-mail in the non-work context, and e-mail in the work context. All ratings for convey activities clustered together, indicating that message conveyance is evaluated similarly across contexts and communication technologies. For choose tasks, context assumed a substantially larger role than was the case for other activities, indicating that subjects in the work context found it especially difficult to make choices using e-mail.

Summary of Results Relating to the Research Model

We began this paper by writing of the need to know what effects context has on user perceptions of CMC. In order to answer this question, we developed an extended TTF model which incorporates context effects. Our test of this model (summarized in Figure 4) supports both the underlying TTF theory and extensions related to context. TTF terms in the research model (i.e., communication technologies, activities, and their interaction) all produced substantial effects on user evaluations, with effect sizes ranging from .65 to .74. Effects relating to context were smaller in size and center on two interactions involving communication technology. The first is a two-way interaction in which ratings of communication media are more polarized in a work context than a non-work context (effect size = .18). The second is a three-way interaction in which convey and choose activities exhibit distinct characteristics from other activities across communication technology and context (effect size = .21). Finally, the findings support the proposition that cognitive effort requirements underlie differences in evaluations of fit across activities. NCE significantly predicts direct effects of activity and interactive effects of activity and communication technology. This result indicates it is possible to predict fit prior to actual usage simply by evaluating the activities that users will perform with the technology.

V. DISCUSSION

The findings suggest several important ways that *context counts* in user evaluations of fit of CMC vs. FtFC. First, in difficult situations users become frustrated with CMC, and they react by lowering their evaluations regarding the technology. This is consistent with similar effects reported among information systems users engaged in demanding, non-routine tasks [Goodhue 1995; Goodhue and Thompson 1995], in situations where there is a high degree of interdependence among tasks [Straus 1999], and in settings that require a high degree of interaction [Wilson 2002]. However, no prior study has reported that such a wide range of activities is affected by context. It is noteworthy that subjects in the work context rated effectiveness of CMC lower than FtFC for every activity except message conveyance. This suggests that differences in user evaluations between contexts are primarily due to perceived capabilities of the technology rather than whether the technology is used for task activities vs. social activities.

Second, the findings of CMC and group systems literatures are skewed by the prevalence of studies that employ only generate tasks. Although it is commonly acknowledged that generate activities are better suited for computer-based communication than other task types [Dennis and Gallupe 1993], our findings indicate that context can exacerbate this effect to a substantial degree. Ratings of generate activities in the work context are .2 (one-fifth of a scale point) lower than in the non-work context, a nonsignificant difference ($F_{1,149}$ = 3.08, p = .081). However, the difference is more than two and a half times as large for the other three task activities, averaging .53 lower in the work context than in the non-work context (choose $F_{1,149}$ = 32.34, $p < .0001$; negotiate $F_{1,149}$ = 10.85, p = .001, execute $F_{1,149}$ = 14.90, $p < .0001$). Prior research shows that it is not valid to generalize results from studies of generate tasks to other task activities within similar research contexts [Dennis et al. 2001]. Our findings caution that it is especially problematic to generalize such results *between* work and non-work contexts.

Third, unexpected interaction patterns appeared between work and non-work contexts among the fit evaluations for generate, choose, and negotiate tasks. These three tasks are theorized to represent respectively increasing interdependencies and associated difficulty [Argote and McGrath 1993], and several researchers have found empirical support for this position [e.g., Hollingshead et al. 1993; Straus 1999; Straus and McGrath 1994]. In two respects, our findings corroborate the theory of increasing interdependencies. Judges in Study 1 assigned NCE z-scores of -.51 for generate tasks, -.11 for choose tasks, and .22 for negotiate tasks, indicating that inherent cognitive effort requirements tend to increase across these task activity domains (generate vs. choose, 61 df, paired-sample t = 3.87, $p < .0001$; choose vs. negotiate, 61 df, paired-sample t = 3.04, p = .003). In addition, Study 2 subjects in the non-work context rated effectiveness of e-mail as 3.93 for generate tasks, 3.57 for choose tasks, and 3.32 for negotiate tasks (generate vs. choose, 59 df, paired-sample t = 4.65, $p < .0001$; choose vs. negotiate, 59 df, paired-sample t = 3.98, $p < .0001$). This indicates that fit of e-mail declines across the activities in the non-work context (see Figure 3). Both these findings support the proposition that increasing interdependencies across the tasks will produce lower evaluations of CMC. However, results from the work context show a different pattern, in which no difference is seen between choose tasks and negotiate tasks. Recall that research supporting the interdependencies hypothesis was conducted primarily in low-obligation settings using student subjects who volunteered to receive course credit [Straus and McGrath 1994]. Our findings suggest that alternative hypotheses are needed to adequately explain the effects of high-obligation settings, as in the work context we studied. It may be that factors beyond intrinsic interdependency become important to task performance in a work context, or that cognitive effort in these situations exceeds certain human limits, creating a plateau effect beyond which evaluations tend to remain constant. This is an intriguing issue that should be addressed by future research.

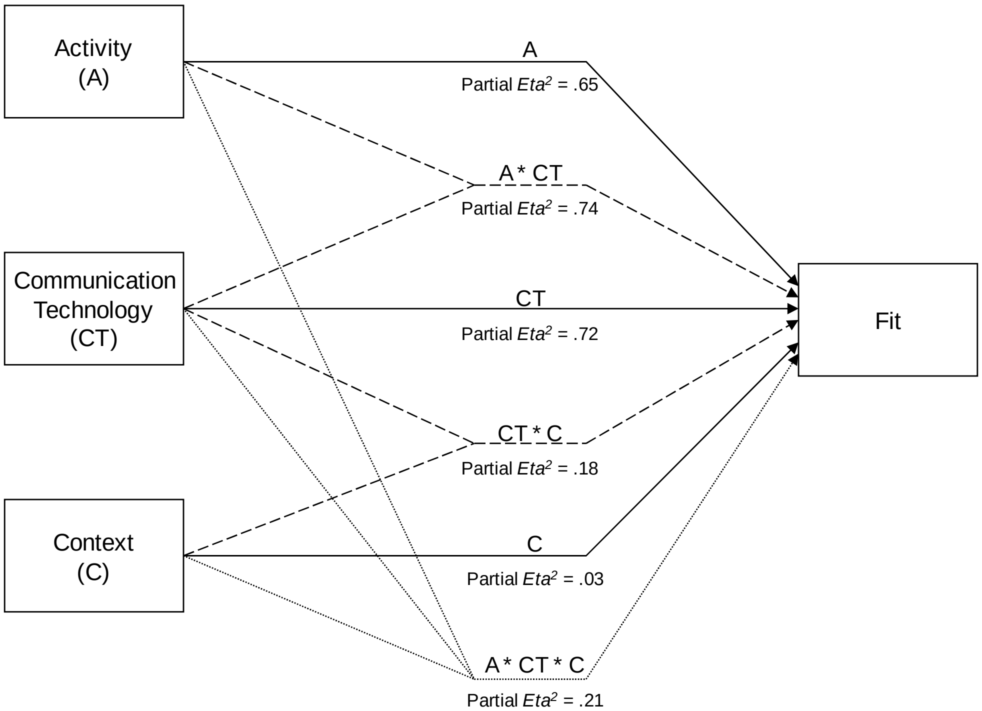

Figure 4. Summary of Significant Study 2 Results Showing Effect Sizes

Fourth, context can provide a valuable backdrop for interpreting research on the effects of experience in CMC. Walther and Burgoon [1992] report that CMC-supported groups become more relaxed, more trusting, and less task-oriented over time. Walther proposes that through *social information processing* communication in these groups becomes less impersonal, and that "development of interpersonal impressions among previously unacquainted interactants requires more time in CMC than in face-to-face interactions, because CMC takes longer to exchange" [Walther 1992, p. 69]. Carlson and Zmud [1999] find that experience using e-mail tends to increase users' evaluations of e-mail's capabilities for supporting timely feedback, custom tailoring of messages, and use of multiple communication cues and rich and varied language in messages. They propose that *channel expansion* occurs during use in which "a set of evolving, knowledge-based experiential factors can positively influence media richness perceptions" [Carlson and Zmud 1999, p. 164]. Our findings suggest that positive effects of CMC experience reported by these authors are dependent upon the context in which experience is gained. Recall that both our subject groups were drawn from the same population at different stages in a required course sequence, thus groups in the work context began their software development projects with approximately the same experience levels as the non-work group had when ending their participation in Study 2. By the end of the 15-week treatment period, therefore, work context subjects in our Study 2 had substantially more experience working in a project team and communicating via e-mail than non-work context subjects (see Table 5). Yet work context subjects perceived e-mail to be significantly *less effective* in most activity domains, including socialization, than did the less-experienced non-work context subjects. No corresponding effect was found for FtFC. This finding suggests that experience, although important *within* a context, does not necessarily transfer *between* contexts. Identifying the conditions under which contextual factors inhibit experience will be an important area for future researchers to explore.

Fifth, the findings support the idea of using NCE to make *a priori* predictions from factors existing prior to the target individual's involvement with a communication technology. As shown by our findings, effect sizes associated with *a priori* predictions typically will not match those of within-process factors, e.g., effects of task-technology interaction on fit in TTF theory. However, these measures offer benefits that can compensate for reduced predictiveness. Researchers can apply predictive *a priori* measures both as independent weights in subsequent analysis as we did in this study or as benchmarks to standardize comparisons between studies. With further refinement, practitioners may be able to apply *a priori* measures prescriptively to guide initial phases of development, deployment, and training relating to CMC and other communication technologies.

Further implications are important for practitioners who use CMC to support organizational communication. The results corroborate prior studies that find CMC is valuable for its ability to convey messages quickly, accurately, and broadly across multiple receivers [e.g., Kettinger and Grover 1997; Pickering and King 1995; Sallis and Kassabova 2000; Sproull and Kiesler 1991]. Our research finds that these first-level efficiency effects also generalize across contexts. These findings reinforce the importance of using CMC to gain specific efficiencies or other tangible benefits. The findings also lend support to the proposition that CMC is qualitatively different from other communication media on a variety of dimensions, and that it often is difficult to transfer experience and metaphors between contexts of use [Wilson, 2002].

The pattern of CMC ratings we found raises questions about the ability of novices to adequately assess problems that may arise in using CMC in a work context. Generate tasks received high ratings in the work context relative to other activities. Yet idea generation and planning tend to be performed at the beginning of work projects. Where individuals lack experience with CMC in a work context, our findings suggest they will develop unrealistic expectations based on their initial successes with generate activities, only to run into problems later in the process where more emphasis is placed on choose, negotiate, and execute task types which show poorer fit with CMC in a work context. Managers should be aware of the potential for reduced performance and morale of CMC-supported teams in these situations, especially among novice team members, and plan ahead to augment CMC with FtFC or alternative communication methods.

Limitations and Future Directions

The design employed in our research has several strengths, including complex testing of multiple activities across two overarching contexts, a strong theoretical basis, a conservative measure of cognitive effort, and treatments that were involving to subjects and were conducted over an extended time period. However, the broad scope of the design brings with it several limitations that deserve further study. There is need to conduct finer-scale research to identify essential dimensions in the relationship of context to fit. The key theoretical difference between work and non-work contexts centers on obligation [Parker 1983], but other dimensions may also prove to be salient dimensions for study, including coordination costs, level of interaction, time pressure, and external incentives.

In Study 2 we described our design strategy of allowing natural variety of contextual factors and variability among contexts to occur outside of the controls implemented by our treatments. This approach proved to be robust within the initial research program we conducted, but it does entail a potential risk that one or more of these contextual factors will influence results in an unexpected manner. In order to learn more about this risk, future researchers should consider alternative designs in which a larger variety of contextual factors and variability among contexts can be controlled or measured within the research design. We took a quantitative approach in our study which limited us to testing pre-set relationships. In order to identify key factors outside of our design it may be more fruitful for future researchers to address these issues with qualitative methods that support in-depth exploration of subjects' perceptions and their rationales for evaluating communication technologies. There also is need to measure other outcomes of communication technology use beyond perceived effectiveness. These include perceptual measures of attitude and intention to use CMC in similar and dissimilar contexts as well as behavioral measures, including subsequent use of CMC. Such relationships are implied by TTF theory [Goodhue 1995], but they have not yet been tested in research designs that study multiple contexts.

The NCE measure introduced in this paper should be extended to assess other factors beyond activity. Future researchers should assess NCE of specific contexts and should study whether it is productive to assess NCE inherent to specific features sets that are implemented in communication technologies. Finally, the design of this study is limited by our use of the unidirectional approach, which assumes that evaluations of technology are context-dependent. Although use of the unidirectional approach is justified by the focus of our study and our objective of relevance to prior CMC research, we believe that studying effects of technology on context and applying the interdependence approach can offer important benefits to CMC researchers, especially those who focus on social change and dynamic changes over time.

VI. CONCLUSION

To answer the question we raised in the introduction to this paper, context can indeed determine users' perceptions of e-mail, producing effects large enough to create contradictory findings among research studies as well as frustrating practitioners. The findings imply that more attention to context is warranted in CMC research, particularly in the form of studies that can be applied to organize the large CMC research literature that already exists. Our strategy was to test for presence of overarching effects using prevalent communication technologies—e-mail and FtFC—and to address contexts that are relevant to major themes within the CMC literature. Development of organizing principles for the existing literature is an important step toward the goal of creating general theories of CMC.

We propose there is a need for CMC researchers and IT researchers in general to develop better mechanisms for making *a priori* predictions of variables of interest. As demonstrated by our NCE measure, predictive *a priori* measures can deliver situational independence and standardization of perceptual factors across studies. Future research will benefit from refining these measures as well as the criteria by which they are evaluated.

Finally, the findings indicate that differential effects of work vs. non-work contexts are too large to be ignored. We anticipate other contextual factors will be important as well. Thus, there is a need to promote studies that address multiple contexts as well as technologies and tasks. With appropriate extensions, TTF theory can provide a solid foundation for studying the role and impact of context in use of CMC and other communication technologies.

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