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Theorizing the Unintended Consequences of Instant Messaging for Worker Productivity

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Abstract
Instant messaging (IM) is one of the newest and fastest-growing communication technologies in the workplace today, yet little is known about its real implications for worker productivity. We have taken the particular affordances of instant messaging as the basis for extrapolating from and linking prior studies of email use, polychronic communication, and task interruptions to develop propositions regarding the unanticipated individual-level productivity implications of widespread IM use in the workplace. We argue that while instant message communication may accelerate particular tasks and decision processes, unstructured IM use will likely contribute to erosion in individualsâ overall productivity due to an increase in usersâ communicative workloads, engagement in polychronic communication, and an increase in the frequency of interruptions. We intend our proposed model and propositions as an impetus for further study of both the benefits and challenges of workplace instant messaging.

Keywords: Electronic communication, instant messaging, unanticipated consequences, unintended consequences, interruptions, polychronic communication, task performance.

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Theorizing the Unintended Consequences of Instant Messaging for Worker Productivity

"The computer industry has never seen a phenomenon like instant messaging. This simple tool for real-time text messaging and presence detection is a staple in consumers' online lives, and it is now poised to change decades-old corporate messaging patterns" (Cain, 2002).

Introduction

Contemporary organizational life is characterized by the use of an increasing number and variety of communication technologies. Fax, voice mail, email, cellular telephony, pagers, web-based conferencing, and internet-enabled personal digital assistants (PDAs) constitute a suite of communication tools now taken for granted as "basic" by many members of today's professional workforce. Belief in the benefits of speed and accessibility has informed and fueled the evolution of communicative technologies represented by the collection of hardware devices and software applications listed here. The scenarios of saved deals, nick-of-time solutions, and prevention of costly errors through rapid, real-time access to clients, suppliers, or other previously "unreachable" collaborators used to sell these new technologies contain an implicit promise of increased productivity and a competitive edge. One of the newest—and most rapidly proliferating—communicative technologies expected to deliver on this promise is instant messaging (IM), an application that supports real-time text message exchange between online parties (*PR Newswire,* June 17, 2002; Perlin, 2003). Estimates of current workplace users range from 12.6 million (Nielsen//NetRatings, cited in PRNewswire, June 17, 2002) to 16.9 million (ComScore Media Metrix, cited in Henry, 2002)), and growing (Fontana, 2002). Like many other communication applications before it, IM has been heralded in the popular media as the "next revolution" in organizational communication (Castelluccio, 1999).

Prior media studies suggest, however, that communication technologies are often used differently than intended (Markus, 1994; Nardi et al., 2000) with unanticipated consequences for both worker productivity and the social dynamics of work (Olson and Olson, 2003; Sproull and Kiesler, 1991). These consequences may either amplify or contradict the technology's espoused purpose and benefits (Kraut et al, 1998; Cecez-Kecmanovic et al., 1999; Orlikowski and Gash, 1994; Sarbaugh-Thompson and Feldman, 1998). With instant messaging's popularity fueled by claims of accelerated decision processes and decreased long-distance telephone costs, little attention has been given to the "second-order" (Sproull and Kiesler, 1991), and potentially negative, consequences of IM use for individual productivity and workplace social dynamics.

We propose that five features of instant messaging—presence awareness, within-medium polychronic communication, "pop-up" recipient notification, silent interactivity, and ephemeral transcripts—that contribute to its popularity will also have second-order consequences. Specifically, we anticipate that IM use will enable changes in personal accessibility, conversation sequencing, and work continuity. Without denying the very real benefits of instant messaging for particular communicative purposes, this paper argues that workers' ongoing, unstructured, day-to-day use of IM may have paradoxically negative consequences for overall individual productivity. In contrast to both critics and skeptical managers, who forecast

productivity declines resulting from unbridled social interaction, we confine our argument to the productivity implications of workers using IM as a communicative tool for legitimate organizational work.

Because of its relative novelty in the business context, IM has only recently captured organizational researchers' attention (Cameron and Webster, 2003; Dabbish and Kraut, 2003; Olson and Olson, 2003; Zweig and Webster, 2002). Consequently, the handful of available studies offer limited commentary on the nature of IM use and its organizational implications (Isaacs et al, 2002; Nardi et al , 2000). Similar to Cameron and Webster (2003), we draw on and extend existing literatures to theorize about IM use and its implications. Weaving together previously unlinked literatures, we propose three mediating mechanisms by which IM use could have unanticipated consequences for overall worker productivity. Specifically, we argue that unstructured IM use will correspond with an increased communicative workload, increased engagement in polychronic communication, and an increased rate of interruptions, each correlating positively with erosions in individual productivity. In addition, we predict reinforcing interactive relationships among the three mediating processes.

This paper contributes a complementary perspective to the emerging studies of workplace instant message use. One stream of IM research has been concerned with understanding and describing *how* and *why* workers use IM in organizational contexts (Cameron and Webster, 2003; Isaacs et al., 2002; Nardi et al., 2000), but the implications of this use for workplace communicative practices and overall worker productivity remain largely unknown except for the anecdotal reports of workers (and researchers) using the technology. Another focus of IM research has been the interruptive nature of IM interaction (Cutrell et al, 2001; Dabbish and Kraut, 2003). There is general agreement that IM communication, in its current form, is interruptive. Dabbish and Kraut (2003) note that, in general, interruptions benefit the interrupter more than the interruptee, but little is actually known about how IM interruptions impact individual productivity or when IM interruptions either facilitate or impede an individual's overall performance. The model presented here provides a theoretically-grounded framework for exploring these unexamined dimensions of workplace IM use.

At the same time, by confining our model and propositions to the implications of workplace instant messaging for individual worker communication and productivity, several aspects of organizational IM use go unexamined. For instance, we do not consider the use of instant messaging for social communication, either inside or outside the workplace. We also do not consider many companies' use of IM to provide customer support. Our focus is the use of instant messaging by individuals in organizations to accomplish legitimate work tasks. In addition, while we recognize that IM capabilities are rapidly evolving to include video, voice, message broadcasting, and application sharing, we confine our analysis to real-time text messaging as it is the most common form of IM being used in organizations today (Caplan, 2001).

The paper begins with an overview of instant messaging technology. Then, extrapolating from prior studies of email use in organizations (Finholt and Sproull, 1990; Sarbaugh-Thompson and Feldman, 1998; Sproull and Kiesler, 1996), we theorize the implications of IM use for users' communicative workloads and the resulting impacts on worker productivity (Brodt et al, 2002). Next, we focus on the particular affordances of IM to draw upon and link studies of two communication practices asserted to be integral to IM use—polychronic communication, or simultaneous participation in more than one conversation (Dabbish and Kraut, 2003; Turner and Tinsley, 2002), and task interruptions (Gillie and Broadbent, 1989; O'Conaill and Frohlich,

1995; Perlow, 1997; Rudolph, 2001). We address each in turn, summarizing our argument in propositions regarding the implications of these practices for individual productivity. To assist the reader in following the argument, we illustrate the propositions in a visual model, developed step-wise in parallel with our discussion of each literature. A simplified overview of the final model is shown in Figure 1. Finally, we discuss the model's research implications for the investigation of workplace IM use.

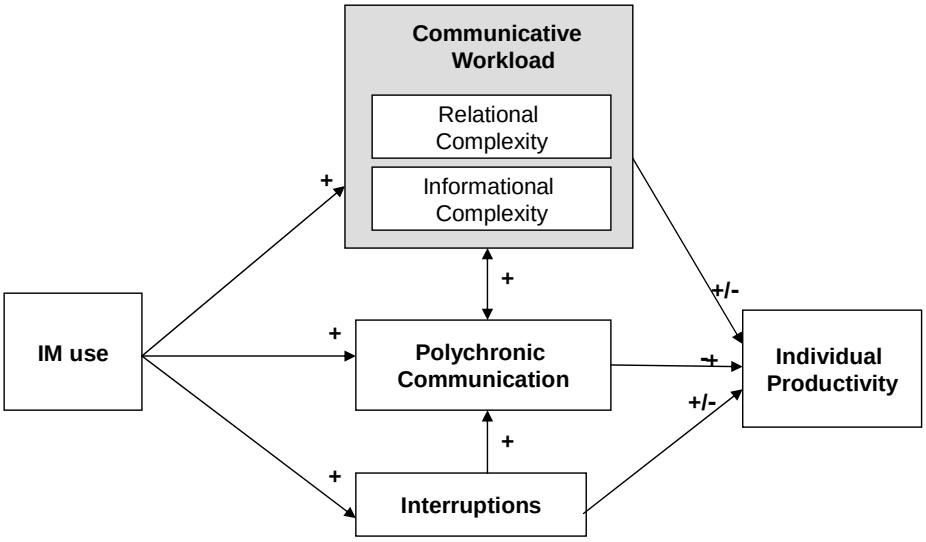

Figure 1. Overview: Model of Unanticipated Consequences of IM

An Overview of Instant Messaging

As defined by Nardi *et al* (2000), instant messaging (IM) is a "tool which allows for near-synchronous computer-based one-on-one communication" (p.2) between online parties. Modern versions of IM trace their roots to the 1970s to the earliest university networks which allowed colleagues to "ping" and chat with others online (Economist, 2002). In 1996, "I Seek You" (ICQ) appeared as a free instant-messaging application that allowed anyone with Internet access to communicate in real-time via text messages (Economist, 2002). By the later 1990s, Internet service providers (ISP), such as America Online, Yahoo, and MSN offered IM as a free or add-on feature (Howarth, 2002), leading to quick penetration of both home and, to a lesser extent, office computing (Economist, 2002). Nonetheless, though estimates and measures of IM penetration vary, all indications are that corporate IM use is significant and growing. For instance, Forrester Research reports that 46% of the top 1,000 companies already use IM (Caplan, 2001); Jupiter Media Metrix (Metrix, 2001), measuring IM use in minutes, claims that total workplace IM use increased 110% in 2001; and the Gartner Group projects that IM use in business will surpass e-mail usage by 2005 (Henry, 2002; Howarth, 2002).

IM Characteristics.

The popularity of IM stems from its unique affordances. While IM has characteristics similar to e-mail (text-based communication) and the telephone (interactivity and intrusiveness), the unique characteristics of IM interaction make it not a "step in the direction of something else, but rather a place of its own" (Caplan, 2001). Five features of IM—*presence awareness, "pop-up" recipient notification, within-medium polychronic communication, silent interactivity,* and *ephemeral transcripts*—result in a unique communicative experience, differentiating IM use from other one-to-one workplace communication media accounting for many of its potential benefits and liabilities for worker productivity. Here we describe each of these features and the communication practices they enable. In the next section we consider the unanticipated implications of these communicative practices for worker productivity.

Presence awareness. "*Presence awareness*," in the form of a dynamic directory of the other currently online users of an IM application, allows users to determine whether a coworker is currently logged onto the system, whether or not the person is accepting messages, and, in many cases, whether or not the person is working on his or her computer, e.g., "active" or "idle." Based on this information, users estimate the probability of success in making contact with the desired coworker. If the desired coworker is not logged on, has been "idle" for a long period of time, or has posted a "do not disturb" or "away" indicator, which may be turned on as an auto reply, the sender is likely to contact someone else, try an alternate channel to reach the desired recipient, or defer the request, saving time on unsuccessful contact attempts. Most IM applications also allow users to automatically monitor the availability of others with whom they most often communicate by creating subdirectories of those users' names. America-on-Line's "Buddy List" is an example of this feature. When any of those others log onto the network, the application then notifies the list owner with an auditory and/or visual cue.

IM systems do typically allow users to retain some control over their accessibility. The "block" feature, for instance, when enabled, prevents receipt of messages from specific other users or obscures one's self completely from visibility in the directory. System capabilities and organizational policies vary with respect to user control, however, typically granting more control to system administrators and higher ranking executives than other users of the system.

"Pop-up" Recipient Notification. Though similar to the telephone in its intrusiveness, IM's *"pop up" recipient notification* feature is unique. Typically, messages open automatically in a new window on the recipient's computer screen, superimposed over any other displays, demanding the recipient's attention, even if only to close or minimize them. Some applications may give users the option of automatically minimizing the IM window to an icon or button on their tool bar, but this feature varies among applications. Unlike e-mail or voice mail, however, users do not have to actively access the medium to retrieve stored messages. Rather, the messages appear automatically as they are received anytime the user is logged into the system.

The intrusion of an instant message also differs from that of a telephone call in that the message content, not just the sender's identity or phone number, appears on the recipient's screen. Depending upon the content—and the recipient's current activity and preferences—this feature could be perceived as either helpful or disruptive, depending upon whether the message content allows the recipient to make better decisions about whether and when to respond or

proves distracting by being unrelated to the task at hand. Nonetheless, users may prefer IM to face-to-face (FTF) interruptions because they may feel more comfortable deferring electronic messages than people standing in their office. In addition, it may be faster to reply using IM.

Within-medium Polychronic Communication. While different media used in combination enable a user to engage in *polychronic communication*, or participation in multiple concurrent conversations (Turner and Tinsley, 2002), IM enables this practice *within the medium*. Polychronic communication is also possible in email, on a multi-line telephone, and in FTF meetings. Instant messaging, however, allows users' juggling of multiple conversations to go undetected. For example, a worker can be simultaneously engaged in an IM conversation with his or her boss, while at the same time engaged in one or more IM conversations with other coworkers. Typically, each conversation will appear in a separate pop-up window on the worker's computer screen, invisible to the others.

Silent Interactivity. Instant messaging is also similar to the telephone in its *interactivity*. It differs, however, in the very important way that text-based interaction is *silent*, allowing users to interact without being overheard by coworkers in close office quarters or by other meeting attendees. For example, in one company, one of the authors observed a manager routinely conducting three to five concurrent silent conversations with his subordinates via IM while attending a face-to-face meeting with his peers (unpublished field data).

Ephemeral Transcripts. The final differentiating feature of IM interaction is the *ephemeral* character of the interaction transcript. In most current systems, unless the users themselves intentionally save the transcript, it is erased when the users close the conversation window. The combination of silence and ephemerality allow for a level of privacy not available by either telephone or email, potentially impacting communication and media use patterns. This "feature" may soon disappear, however, as developers add archiving and transcript-searching capabilities to new versions of applications in response to managers' concerns about intellectual property security and appropriateness of workplace interactions (Griffith, 2002; Poe, 2001).

Table 1 summarizes the characteristics of instant messaging described here, comparing it with other one-to-one communication media commonly used in the workplace.

While Table 1 reflects the current features of most IM applications in use in organizations today, it is important to realize that IM continues to evolve, offering increasingly sophisticated communicative capabilities (Callaghan, 2002; Chen, 2003; Economist, 2002; Woods, 2001). Coming versions of IM promise to enable audio- and video- messaging, asynchronous and broadcast delivery modes, application sharing, and archived message transcripts. While these features may become more widespread in time, this paper focuses on the use of interactive text applications that support presence awareness, "pop up" recipient notification, polychronic communication, silent interactivity, and ephemeral transcripts since these represent the typical capabilities of the IM systems most prevalent in organizations today.

The current usage and projected growth of IM in business organizations suggests that whatever its implications for worker and organizational effectiveness, they will be widespread and, therefore, of interest and significance for both research and practice. If IM follows a similar

Technology	Technology Attributes and Features of Enabled Communication					
	Text-Based	Synchronic/ Interactive	Allows Presence Awareness	Intrusive	Polychronic within	Supports Archivable Communication
IM	Yes	Yes	Yes	Yes	Yes	No[1]
Email	Yes	No	No	No	No	Yes
Fax	Yes	No	No	No	No	Yes
Phone	No	Yes	No	Yes	Yes	No[2]
Face-to-face	No	Yes	Yes	Yes	Yes	No

[1]Some applications do support logging of IM use and developments are in process to allow content archiving as well, but current applications are generally considered ephemeral.
[2] While phone conversations can be recorded, this is typically considered an unusual practice in the majority of work contexts.

Table 1. Comparison of One-to-One Communication Media

trajectory as prior technologies, communicative or otherwise, we expect managers to implement IM based on claims of its benefits only to later discover the unanticipated consequences of their choices (Thomas, 1995). By drawing on prior studies of electronic communication and other research relevant to the particular affordances of IM, we argue that at least some of the deleterious impacts of IM use on worker productivity can be anticipated.

Theoretical Foundations.

Based on the five characteristics of IM communication outlined above, we identified three previously unlinked literatures relevant for theorizing the implications of workplace IM use for individual productivity—computer-mediated communication (CMC), polychronic communication, and task interruptions. Extending and synthesizing these literatures, we develop a model composed of three concurrent mediated paths by which we propose IM use will impact worker productivity as well as synergistic relationships between the mediators. For purposes of this model, we adopt a very generic definition of productivity: *the work accomplished in a given time period with a given set of resources*. For instance, "X" work accomplished in one day with "Y" resources would be more productive than the same work accomplished with "Y+1" resources or in two days. In future empirical tests of the model, "productivity" would need to be translated into contextually appropriate measures.

First, we extend studies of email use, which comprise a significant portion of the CMC literature, to hypothesize a relationship between IM use and individual productivity mediated by the individual's communicative workload. Next, we draw upon Turner and Tinsley's (2002) notion of "polychronic communication," or the simultaneous participation in more than one conversation, to theorize the implications of IM's ability to support within-medium polychronic communication for workers' communicative practices and subsequent productivity. Finally, we

synthesize the interruptions-task performance literature, an area of interest among IM researchers (Cameron and Webster, 2003; Cutrell et al., 2001; Dabbish and Kraut., 2003), to propose a third relationship between IM use and individual productivity mediated by task interruptions. As we develop the argument for each of these direct effects, we also consider possible interactions among the mediating processes.

Communicative Workload.

Studies building on the work of Hiltz and Turoff (1985; 1993) have shown that email use amplifies users' overall communicative activity (Finholt and Sproull, 1990; Sproull and Kiesler, 1991; Sproull and Kiesler, 1996; Sarbaugh-Thompson and Feldman, 1998). These studies showed that, in differing contexts, when given access to electronic communication channels, the overall volume of communication among a group of people increased and the diversity of a worker's co-communicants also increased. In other words, workers with access to electronic communication tools interacted more, with more people, from more different social groups than they did prior to using the tools. These increases in both the volume and diversity of workers' communication has been seen as both a benefit and liability of communicative technology use (Hiltz and Turoff, 1985; Kraut et al., 1998; Sproull and Kiesler, 1991).

IM Use and Communicative Workload. Brodt et al (2002) use the terms *informational complexity* and *relational complexity* to differentiate the volume of interactions from the diversity of co-communicants. *Informational complexity* refers to the number of different communicative events in a given time period. In Brodt et al's study, participants interacted entirely in email, so they equated informational complexity with the number of messages received. For purposes of this paper where we concern ourselves with real workplace communication, the measure of informational complexity would include communicative events in all media. In synchronous communication, a communicative event would consist of a complete conversation composed of multiple turns, but in asynchronous interaction, each message would constitute a separate communicative event, even if the message is part of an ongoing exchange, because the receipt of and response to each message represents a discrete activity in a worker's day.

Workers' roles and identities vary with respect to the various others with whom they interact, requiring modifications in communicative strategy, including response rate, message length, language, and tone, when switching between conversations. *Relational complexity*[2], or the number of different social groups with whom a person interacts (Brodt et al., 2002), offers one measure of this dimension of communicative work. Empirical measures of relational complexity should be contextually-specific and reflect the workers' mapping of the "social groups" with whom they interact, rather than *a priori* designations based on formal organizational roles. For instance, an automotive engineer may interact with other engineers from the engine, safety, transmission, and fuel efficiency departments but may regard these as members of a single social group, "the Model XYZ design team." At the same time, the same engineer may regard two other coworkers, both from the engine division, as coming from different social groups because each is associated with a different project team or engine style and, thus, uses a different vocabulary.

[2] Also referred to as "social density" (Hiltz and Turoff, 1985).

Though informational and relational complexity vary independently, each with implications for productivity, for much of our discussion in this paper, we find it helpful to use the term *communicative workload* to indicate the combination of the informational and relational complexity of a worker's communicative activity because an increase in either dimension requires the doing of more work—processing more, and more different kinds, of information; coordinating more interdependencies; managing more relationships; physically participating in more conversations; etc..

One important way communicative technology use impacts workers' communicative workloads is by altering their access to one another. In general, the trend in technology design has been to enable increased access by making accessible more people more hours of the day and in more locations, resulting in increased overall communication. For instance, the telephone offered access to distant contacts, but for many years, required synchronous availability of the caller and receiver. Then, email further expanded access to others by enabling both asynchronous interaction and broadcast communication to groups, including members unknown by the sender. Though people using instant messaging typically also use the telephone and email, the presence awareness capability of IM even further expands users' access to one another. Dabbish and Kraut (2003) note that CSCW studies in the 1990's repeatedly showed that "availability displays," such as the directory of online users in IM systems, resulted in increased communication rather than improved regulation and coordination, as the designers had intended. They do not, however, offer any explanation(s) for the observed pattern.

We suggest that there are at least three ways the presence awareness feature, or availability display, of IM applications encourages communicative activity. The first is by making salient the presence and availability of more people. Receiving notification that someone has logged onto the network or seeing a person's name, perhaps while scanning the list looking for someone else, brings the person to mind, potentially prompting an interaction that might not have otherwise occurred, the electronic version of a chance encounter in the hallway.

The availability display also increases a communicator's ability to estimate the likelihood of success in contacting a coworker. For instance, a worker in the middle of a project who encounters a question will likely scan the display for helpers and send an IM to an "available" team member or expert rather than sending an email or making a telephone call to someone whose availability is unknown.

Detection of real-time availability may also prompt communication in other media. For instance, seeing that someone is logged onto the network and active, users we observed called the available party on the telephone, sent an IM, or walked to the other person's desk (in the case of collocation) in instances where they otherwise would not have taken the time to look for the person or did not want to wait for a reply to a telephone or email message (unpublished field data), resulting in a conversation that otherwise would not have happened.

Finally, the hyperlink functionality of the directory gives users direct access to one another, including to managers or executives whose communication, even email, may otherwise be filtered by gatekeepers. The alphabetical listing of all online users also contributes to a sense of egalitarianism and informality (Cameron and Webster, 2003), eliminating at least some of the material status cues, such as secluded offices, differences in attire, etc., that might otherwise discourage interaction (Sproull and Kiesler, 1986).

It is both possible and likely that IM interaction functions as a substitute for at least some conversations in other media (Cameron and Webster, 2003). At least some users, nonetheless, regard it primarily as an addition to the suite of available tools and channels, rather than as a

replacement (Gartner Group, as cited in Caplan, 2001; Howarth, 2002). Even workers who regard IM as a replacement technology, though, acknowledge that some of their conversations would not take place in the absence of IM (Cameron and Webster, 2003). Two examples from different organizations are illustrative. At one high-tech organization, engineers use IM throughout the day because they know their managers and coworkers only check email in the morning and evening. Yet they also use email to communicate with these same people. In fact, they sometimes use IM to ask a coworker to check his or her email (personal communication, June 2003). In an energy generation and distribution organization, we observed workers using the IM directory to identify people whom they would otherwise not contact to make brief inquiries about policies, practices, or schedules in that person's department (unpublished field data). These workers viewed an instant message as a low-risk, low-investment initiative on their part and as making a sufficiently minimal demand on the other party as to be considered acceptable even in the absence of a substantive relationship, similar to asking a stranger for the correct time. For these reasons, we argue that IM use will not simply replace communication via other media but will, in fact, lead to increased communicative activity.

> ***Proposition 1:*** IM users' communicative workloads, in terms of both informational and relational complexity, will exceed pre-IM levels and the communicative workloads of non-IM users in similar organizational roles.

Communicative Workload and Productivity: Informational Complexity. Increases in the communicative workload beyond a person's capacity to effectively manage either the volume or diversity of interactions could result in productivity declines (Brodt et al., 2002; Dunlop and Kling, 1991; Hiltz, 1988; Hiltz and Turoff, 1985, 1993; Mick and Fournier, 1998; Schenk, 1997; Weick, 1985). In an experimental study varying the number of received emails and the diversity of senders, Brodt et al (2002) found that increases in informational and relational complexity, respectively, were each linked to erosions in communicative performance which was measured as the number of messages to which subjects were able to respond in a given time. This measure of communicative performance corresponds with our definition of productivity, only limited, in this case, to communicative activity. In a knowledge work context, much of the work is communication (Dabbish and Kraut, 2003; Mintzberg, 1997; Panko, 1992; Reder and Schwab, 1988; 1990), so a decline in communicative performance effectively constitutes a productivity erosion. In addition, because the communicative performance erosion observed by Brodt et al (2002) occurred in an experimental context where email constituted the participants' only task, we reason that in a real practice setting where workers manage multiple activities, an increase in communicative workload—whether in informational complexity, relational complexity, or both—is even more likely to correspond with a productivity decline.

While an intuitively sound notion, few studies have actually attempted to investigate and articulate the relationships between informational and relational complexity, respectively, and work productivity (Brodt et al., 2002; Kock, 2000). Here we extrapolate from prior studies to offer a first approximation of these relationships as a starting point for empirical study.

Communicative Workload and Productivity: Informational Complexity. There is reason to believe that the relationships between productivity and both informational and relational complexity, respectively, are nonlinear. Human factors research (Hiltz and Turoff, 1985; Rouse,

1975) has shown that human performance declines if the workload is either too large or too small. While we have defined communicative workload to include both informational and relational complexity, we interpret Rouse's conclusions to apply primarily to the quantity of work to be accomplished and, therefore, relevant mainly for predicting the relationship between informational complexity, or communicative volume, and productivity. We show this relationship as an inverted "U" in Figure 2.

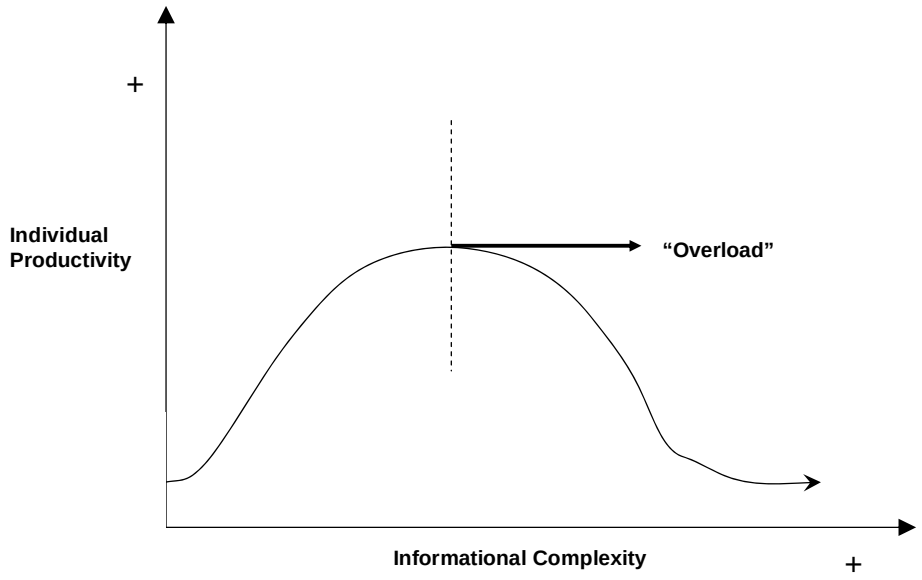

Figure 2. Relationship between the *Informational Complexity* of an Individual's Communicative Workload and Productivity

The initial incline in Figure 2, shows an increase in communicative volume corresponding with an increase in productivity up to a certain point. The peak and leveling off of the curve indicate "saturation," or the equilibrium between the communicative volume and a worker's cognitive and tactical capacities for processing interactions (Kramer and Spinks, 1991; Miller, 1956). When the communicative volume, in combination with other cognitive demands, exceeds the worker's capacity, the condition known as "information overload" or "communicative overload" occurs, and overall productivity declines (Brodt et al., 2002; Davis, 2002; Edmunds and Morris, 2000; Hiltz and Turoff, 1985). We expect the exact parameters of this curve to vary across individuals depending upon their idiosyncratic information processing capabilities and their strategies for managing the communicative load (Hiltz and Turoff, 1985; Kock, 2000) and to vary within individuals according to changes in concurrent work demands.

In hypothesizing this relationship, we are assuming a positive linear correlation between *communicative* productivity, that is, the number of satisfactorily completed interactions in a given time period, and overall work productivity. While we recognize that communicative productivity is not a perfect proxy for work productivity, we hold that in the communication-intensive contexts of contemporary professional and managerial work (Dabbish and Kraut, 2003; Davis, 2002; Mintzberg, 1997; Panko, 1992), it is a reasonable one. Many knowledge work tasks require communication—whether by paper, phone, or computer—to give and receive

information needed to complete the work and contribute to larger processes moving ahead. For instance, it is possible to imagine an increase in the number of interactions corresponding with more rapid and direct access to information, engagement in more tasks, or a more efficient division of labor requiring coordination with multiple coworkers, each scenario corresponding with an increase in both individual and collective productivity. While this assumption may not hold in particular work contexts and, thus, should be questioned in any empirical test of the model, we offer it as a reasonable first approximation of the informational complexity-productivity relationship.

> ***Proposition 2a:*** Increases in informational complexity secondary to IM use will correspond with increases in productivity up to a threshold that will vary across individuals. Any further increase in informational complexity beyond this threshold (into "overload") will then correspond with a productivity decline.

Kock (2000), reporting a survey and interview study of part-time MBA student professionals, denies that such a relationship exists and instead predicts that each experience of "overload" represents a transient condition preceding an *increase* in productivity as workers develop new skills and tactics for handling the increased level of information. Though Kock's methods make his findings suspect for this particular phenomenon, Hiltz and Turoff (1985) also found a negative correspondence between workers' *perceptions* of "overload" and their use level tenure of experience with an electronic message system, suggesting that experience and skill may effectively counterbalance increases in workload. Though Brodt et al (2002) found that study participants' perceptions of "overload" were not a good indicator of actual performance, both the Kock and the Hiltz and Turoff studies suggest that time, in terms of experience with a technology, may play an important role in the relationship between informational complexity and productivity, calling for longitudinal study designs. Nonetheless, the oft-replicated finding that individuals have relatively fixed information processing capacities (Kramer and Spinks, 1991; Miller, 1956) argues for the proposed relationship with minor variations at the individual level.

Communicative Workload and Productivity: Relational Complexity. Relational complexity, and its implications for productivity, has been even less studied than informational complexity and is, in fact, rarely mentioned in studies or discussions of "overload" (Brodt et al, 2002). Hiltz and Turoff (1985; 1993) predicted that workers will be overwhelmed by the "social density" of technology-mediated interaction but did not, to our knowledge, investigate the relational complexity-productivity relationship. Brodt et al (2000) may be the only published study in English-speaking academic outlets that has empirically tested this relationship. They found that experimental study participants assigned to a "high" level of relational complexity responded to fewer email messages than those assigned to the "low" relational complexity condition, independent of the number of messages received. Drawing on social identity theory (Ashforth and Mael, 1989), they explain that participation in a social group involves effort to establish, validate and sustain an identity, position, and relationships in that group. As the number of membership groups increases, so do the relational demands. In addition, some of the demands may be in conflict or compete for the person's time and attention, eventually compromising productivity.

Brodt et al (2002) only tested two levels of relational complexity and, consequently, interpreted the (negative) relationship between relational complexity and communicative

performance to be linear. In contrast, we hypothesize a curvilinear relationship as shown in Figure 3.

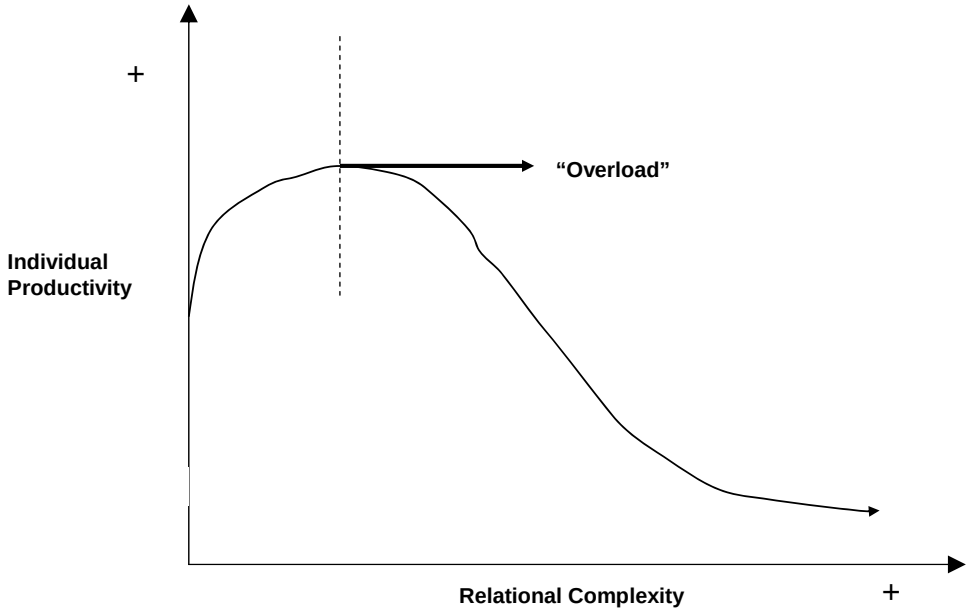

Figure 3. Relationship between the *Relational Complexity* of an Individual's Communicative Workload and Productivity

At very low levels of relational complexity, productivity is relatively high, as found by Brodt et al (2002), presumably because, all else being equal, the worker has fewer process losses from transitioning between identities and systems of meaning. Similar to the hypothesized informational complexity-productivity relationship, and in contrast to Brodt et al, we predict that an initial increase in relational complexity will correspond with an increase in productivity up to a point of "saturation" (Gergen, 1991) that, again, would vary between individuals, depending upon skills and experience, and within individuals, depending upon concurrent work demands. Any additional increases beyond this threshold will result in an "overload" condition.

Our reasoning is that some increase in relational complexity would occur in conjunction with engagement in an additional project, seeking information from new sources, and partnering with new collaborators, all of which would increase the relational complexity of the worker's communicative load but would, at the same time, (hopefully) correspond with an increase in worker productivity. At some point, however, we would expect the productivity benefits of expanding one's contacts to level off as the coordination costs come to counterbalance any productivity gained from an additional division of labor. This is not to say that the worker might not gain other benefits from an ever-expanding network, such as weak ties (Constant et al., 1996; Pickering and King, 1995) and tidbits of useful information that contribute to longer-term productivity (Davis, 2002; Hiltz et al., 1985; Kock, 2000). Nonetheless, short-term productivity is likely to suffer in the interim.

Proposition 2b: IM use corresponding with increased relational complexity will correspond with an increase in productivity up to a threshold that will vary across individuals. Increases in relational complexity beyond this threshold will then correspond with productivity declines.

A reasonable counterargument to this proposition is that an individual, assigned to a new task or seeking a new bit of information, might be put in a position to initiate numerous queries to new contacts, exhibiting a temporary increase in the relational complexity of his or her communicative load but with a corresponding productivity decline rather than an improvement. While a *plausible* scenario, we think it does not accurately depict most workers' "typical" days and would represent an outlier—though perhaps an interesting one—in an empirical data set.

Brodt et al (2002) anticipated but did not find an interaction effect between relational and informational complexity in the experiment they reported. In discussing their results, however, they speculated that the experimental context may have precluded the participants' perception of relational demands by the senders, effectively obviating the impact of the relational complexity except for the cognitive load of responding appropriately to diverse senders within the allotted time. We concur with their reasoning and, therefore, hypothesize that an interaction effect exists between informational and relational complexity and would be evident in studies of workers in their natural settings. We do not yet, however, have a practical, theoretical, or empirical basis for hypothesizing the shape of this relationship, so we have confined our propositions to the direct effects, pending empirical verification, and have not yet included an interaction effect in the model. Nevertheless, we think this is an important arena of inquiry and encourage future investigation. Figure 4 summarizes the relationships described in propositions 1, 2a and 2b, illustrating the first of the three mediated paths between workplace IM use and individual productivity.

Moderators: Communicative Workload and Individual Productivity. Figure 4 also includes three factors believed to moderate the relationship between informational and relational complexity, respectively, and individual productivity: the individual's information processing capacity; strategies for managing both informational and relational complexity; and other task demands. Prior research shows that human beings have a finite cognitive capacity, preventing them from fully processing every piece of information they encounter (Kramer and Spinks, 1991; Miller, 1956). This research formed the basis both for Brodt et al's (2002) study design and their interpretation of the measured performance deterioration corresponding with an increase in the informational complexity of study participants' communicative load. Individuals may augment or improve their apparent information processing capacity with strategies for managing communicative volume and diversity such as filtering, prioritizing, and multi-tasking (Davis, 2002; Hiltz and Turoff, 1985; Kock, 2000).

Finally, we would expect that the shapes of the informational complexity-productivity and relational complexity-productivity curves, including the optimal, or "saturation," levels to vary in response to other task demands. For instance, if a worker's task load consists solely of interacting with others about familiar topics, we would expect his or her productivity to

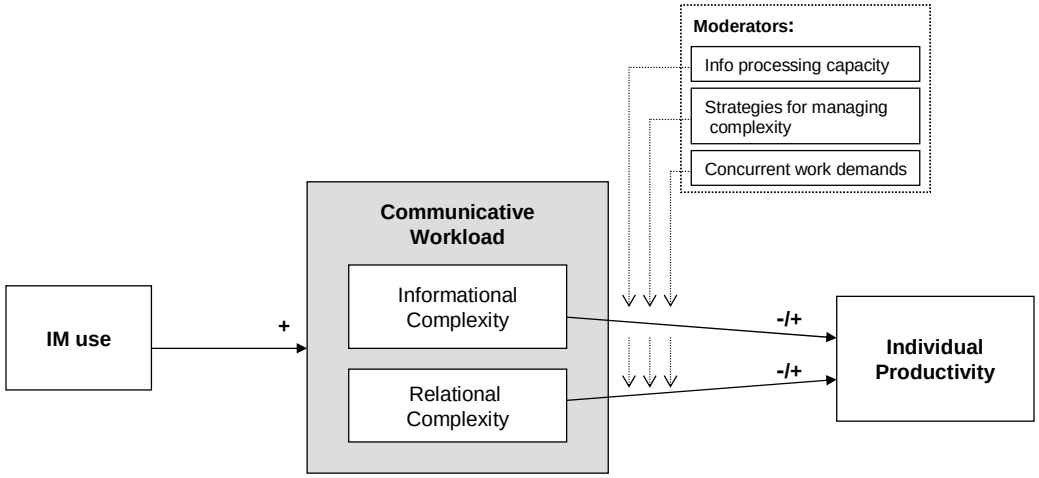

Figure 4. Consequences of IM use for Individual Productivity Mediated by Impacts on Communicative Workload

exceed that of an individual's whose work load consisted of analyzing numerous files of information, learning about a new material or machine, and communicating with others about both familiar and unfamiliar topics.

It seems reasonable to expect these moderating factors to remain relatively constant for some period of time for a particular group of workers in a particular practice setting. Consequently, we suggest they be treated as control variables in selecting a sample and analyzing the data in any empirical tests of the model.

Polychronic Communication

Prior studies of technology-mediated communication have tended to focus on the use of a single technology or comparing the use of two technologies. Contemporary workers, however, typically utilize multiple technologies, as well as face-to-face communication, in various combinations to conduct their day-to-day activities (Turner and Tinsley, 2002). Turner and Tinsley (2002) note that workers often use these technologies simultaneously to manage multiple concurrent conversations, a practice they call "polychronic communication," based on Bluedorn's (1999; 2000; 2002;) studies of polychronic activity. For example, individuals can now be on the telephone, reading and responding to email messages, receiving and sending instant messages, and engaging in one or more face-to-face (FTF) conversations at the same time in differing combinations. We expect IM use to amplify the frequency of this practice, with predominantly negative implications for individual productivity.

IM Use and Polychronic Communication.

Several features of instant messaging facilitate, and even encourage, the practice of polychronic communication. First, the technology itself supports multiple concurrent conversations. Users may participate in as many conversations as they can manage, often limited only by the availability of screen or toolbar space ("real estate") to accommodate the dialogue windows or minimized icons. In addition, because an instant message typically "pops up" on a user's computer screen rather than being stored in a repository awaiting the recipient's attention, as is the case with email, IM encourages and enables message recipients to participate in an IM interaction while continuing their original activity. In the event that the original activity is another conversation, such as a computer conference, email, telephone call, or face-to-face conversation, continuing the original activity would constitute polychronic communication. Consequently, we predict a positive correlation between an individual's use of instant messaging and the frequency with which they communicate polychronically.

> ***Proposition 3*:** IM use will correlate positively with frequency of polychronic communication.

Moderators of Polychronic Communication and IM use.

Turner and Tinsley (2002) hypothesize that several factors moderate whether and when workers will engage in polychronic communication: the characteristics of the message to be conveyed, the relative status of the communicators, the media involved, organizational norms, and individual skills and preferences. According to Turner and Tinsley (2002), workers are more likely to engage in polychronic communication to manage "urgent" messages or to allow non-urgent conversations to be interrupted. They also hypothesize that a message recipient is more likely to engage in polychronic communication to accommodate someone of higher status than someone of lower status. The media involved will also influence whether or not a worker engages in polychronic communication under a given set of communicative circumstances. For instance, it would be more difficult, and possibly more socially unacceptable, to engage in both a cellular telephone conversation and a face-to-face meeting than to respond to an IM while on the telephone or at a meeting. Each of these aspects of a worker's communication—message characteristics, relative status of the communicators, and media involved—will vary from one conversation to the next, moderating whether or not an individual engages in polychronic communication at a particular point in time. As the majority of communication in most organizations is non-urgent, among peers, and conducted via a variety of media, we expect these factors to have a negligible impact on an individual's polychronic communication practices when measured at the aggregate level of a day or a week.

In contrast, organizational norms and individual skills and preferences could skew polychronic IM use—either inhibiting or encouraging—at the aggregate level. For example, despite the deployment of IM to facilitate spontaneous interaction among distributed collaborators, an organization's communication may still be characterized by a norm against interruptions, so workers may not respond to an IM until having completed a telephone call, a face-to-face conversation, or another IM conversation (unpublished field data). Workers in such an organization would also be unlikely to use IM during a meeting. In contrast, in another organization, it may be expected that workers wear cordless telephone headsets and carry internet-enabled wireless devices, such as a PDA or cellular phone, to facilitate simultaneous engagement in telephone, email, IM, and face-to-face interaction.

An individual's idiosyncratic communication and technology skills and preferences will have a similar skewing effect on whether an individual uses IM polychronically. It seems obvious to say that people who like to communicate polychronically and have better technology skills are more likely to communicate polychronically than those who do not, but it is important to make explicit the agentic nature of IM use so that this factor will not be overlooked in future empirical tests. To consider the range of influence exerted by variations in skills and preferences regarding polychronic IM use, we disaggregate *skills* and *preferences*, expressing each in terms of a polar dichotomy—like/dislike; skilled/unskilled. The possible combinations of these dimensions can be illustrated in a 2x2 matrix as shown in Table 2. We propose that the influence of individual skills and preferences on the polychronic use of IM ranges along a continuum from avoidance of polychronic communication (dislikes polychronic communication and unskilled technology user) to enthusiastic polychronic interaction characterized by experimentation with technologies to find even more ways to communicate polychronically (prefers polychronic communication and skillful technology user).

In summary, we reason that while IM applications enable polychronic communication, whether or not and when individuals actually use the technology in this way will be shaped by individual, interpersonal, and organizational characteristics. The resulting level of polychronic communication, we argue, in turn impacts an individual's level of productivity.

Polychronic Communication and Productivity.

Under the rubric of "multi-tasking," or doing many activities simultaneously, the mass media typically depicts polychronic communication as an individual's key to ultimate productivity. More recently, however, cognitive function studies have indicated that multi-tasking may be inefficient and actually lead to reduced mental capacities (Carpenter et al., 2000; Just et al., 2001; Rubinstein et al., 2001; Shellenbarger, 2003). Particularly relevant studies include investigations of the process and consequences of task switching and brain imaging studies of individuals performing singular versus multiple tasks.

Rubinstein et al (2001), investigating the time costs of switching between activities that varied in familiarity and complexity, found that when switching between tasks, people exhibit a delay before engaging effectively in the new task. Each switch incurred a time loss, even if the worker had been previously engaged in the task. Lost time was greater when moving from a familiar to an unfamiliar task and from a simple to a more complex one.

Workers may or may not experience polychronic communication as "switching." If a worker is engaged in multiple conversations about the same project, perhaps coordinating the efforts of several collaborators, movement among conversations in different media may not be *experienced* as switching. From a cognitive function perspective, however, moving between media would constitute a switch because each medium requires different motor actions and a different syntax for organizing information—synchronous phone conversations have a different syntax than voice mail, email uses a visual rather than auditory representation of information, etc.—activating and calling upon different portions of the brain. Based on Rubinstein et al (2001), we would expect a worker carrying on multiple conversations about the same project to experience process losses. These may, however, be sufficiently smaller than the simultaneous coordination gains as to be considered negligible. Workers engaged in multiple conversations about *different* topics, however, would be switching among tasks as well as media, and would be expected to suffer the greatest productivity declines.

In the brain imaging studies (Carpenter et al., 2000; Just et al., 2001), researchers monitored and analyzed the MRIs of study participants performing singular and multiple tasks. The multiple task conditions included sets of similar tasks, meaning ones that draw upon the same area of the brain such as listening to two information sources simultaneously, and sets of dissimilar tasks, ones believed to draw upon independent cortical systems such as listening and performing a simple physical task. The studies showed that when performing multiple tasks, regardless of similarity, the activity level in the affected brain area(s) was less than when performing the tasks singularly *and* that the activity levels from all the engaged portions of the brain summed to less than the activity level of performing any one of the activities independently. In other words, when performing multiple tasks, study participants exhibited less total brain activity than when performing a single task. The researchers concluded that while it is *possible* to perform multiple activities simultaneously, each task will likely be performed less effectively and less efficiently than if it was performed independently. Based on these studies, we argue that polychronic IM communicators will exhibit decreased individual productivity.

> ***Proposition 4:*** IM users who communicate polychronically, using IM alone or in combination with other media, will exhibit lower productivity than non-IM users or IM users who communicate monochronically.

Workers using IM to communicate polychronically may make a valuable contribution to organization or team productivity by keeping several conversations moving simultaneously, avoiding the "bottleneck" of a queue, while compromising their personal productivity. The model developed here, however, focuses on the individual level of analysis.

Polychronic IM Use and Communicative Workload.

Besides the direct effect of polychronic IM use on productivity proposed in proposition 4, we also propose that polychronic IM use will impact worker productivity indirectly through its bearing on communicative workload. Because polychronic communicators engage in several conversations simultaneously, we reason that they can participate in more interactions in a given period of time, further increasing their respective communicative workloads.

A plausible counterargument is that polychronic IM use could decrease the number of communicative iterations required to complete a task by facilitating information exchange among collaborators, effectively decreasing the communicative workload. Nonetheless, polychronic IM use also enables concurrent interaction about multiple tasks, so we reason that any decrease in communicative activity due to shortened information cycle times will be more than compensated for by increases in the number of concurrent conversation topics.

> ***Proposition 5a:*** IM users who engage in polychronic communication will experience a higher communicative workload than IM users who do not engage in polychronic communication.

Conversely, one may also reason that it is not the affordances of the technology but the person's communicative workload that encourages polychronic communication. Informed by a belief in the benefits of multi-tasking, workers may use IM to communicate polychronically as a strategy for managing the burgeoning communicative demands made on them by others.

***Proposition 5b*:** IM users with a higher communicative workload will communicate polychronically more than IM users with a lower communicative workload.

In the absence of empirical evidence to suggest one direction over the other, we hypothesize that the relationship between polychronic communication and communicative workload is bidirectional. In a field setting with established communicative practices, it may be analytically impossible to differentiate one direction of the relationship from the other, seeing the relationship instead as a self-reinforcing dynamic.

We summarize the relationships expressed in Propositions 3, 4, 5a and b in Figure 5.

Interruptions and Productivity.

As defined by O'Conaill and Frohlich (1995), an interruption is "a synchronous interaction which is not initiated by the recipient, is unscheduled, and results in the recipient discontinuing their current activity."[3] Instant messaging is inherently interruptive. Similar to telephone calls or spontaneous face-to-face encounters, workers send instant messages spontaneously to "available" others with little or no knowledge of the recipients' actual work activities or cognitive receptiveness to being interrupted. Though initiators may simply substitute instant messaging for interruptions via other media and recipients may take action to regulate the rate of interruptions, the unique affordances of IM make possible more—and more disruptive—interruptions with overall negative consequences for recipient productivity.

IM Use and Interruption Volume. The unique affordances of instant messaging applications enable interruptive practices either not technically possible or socially acceptable in other media, resulting in an increase in the net volume of interruptions. For instance, when a message recipient is talking on the telephone, incoming calls often queue up as messages in the voice mailbox, invisible and inaudible to the recipient rather than interrupting. Face-to-face visitors, finding the recipient on the telephone, may defer his or her intrusion until the call ends. Call recipients who do have a multi-line phone or "call waiting" feature may respond to the signal for an incoming call but typically feel the need to apologize for the interruption and then to either return quickly to the original call or terminate it if the delay will be lengthy. If many such interruptions occur, the recipient eventually either ignores the incoming calls or ends the original call, apologizing for the recurring interruptions.

[3] In a synthesis of the interruptions literature, Jett and George (2003), differentiate four types of interruptions—intrusions, breaks, distractions, and discrepancies—to encourage more fine-grained research. The definition we use here includes "intrusions" and "distractions" but does not address "breaks" or "discrepancies." We do not include breaks because these are typically initiated by workers themselves or are scheduled, and so not unplanned. We do not include "discrepancies" because we interpret these to be events that trigger cognitive schema shifts but that may or may not interrupt a person's work activities at a particular point in time.

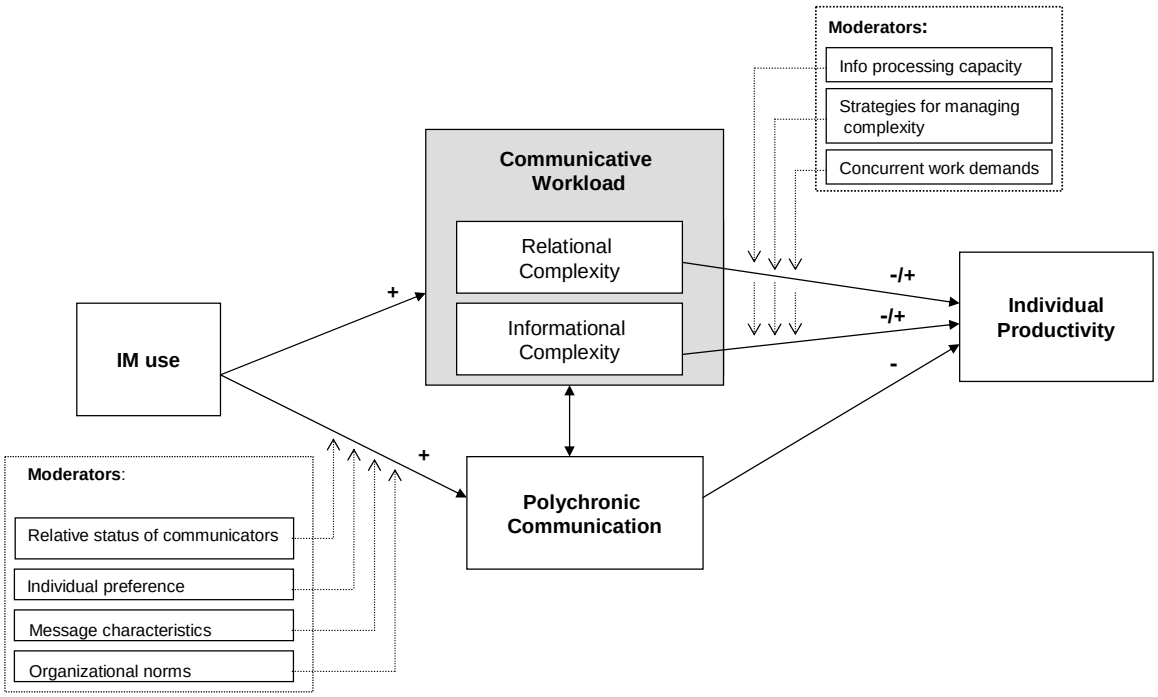

Figure 5. Consequences of IM Use for Individual Productivity Mediated by Polychronic Communication Practices and Effects of Polychronic IM Use on Communicative Workload

Similar to the voice mail queue, multiple face-to-face visitors also tend to queue up, waiting their turn to speak with a particular person. In contrast, instant messages arrive, "opened," exposing the recipient to their content regardless of whether a telephone or face-to-face conversation is in progress. In fact, message senders may regard the intrusiveness of IM as a "feature." For instance, participants in Cameron and Webster's (2003) study reported that when they found a line of people waiting to speak to a collocated coworker, they often used an IM to interrupt the conversation in progress, effectively "jumping the queue," an unacceptable practice in a physical, face-to-face context.

Finally, in contrast to both the voice mail and the face-to-face queues, multiple instant messages may open simultaneously or in quick succession, each message potentially interrupting the recipient's attention to another. Even if the recipient only glances at the message to determine its relevance and urgency compared to the conversation in progress, the recipient's attention has been interrupted.

The increased access afforded by the presence awareness display discussed earlier also extends users' temporal and geographical reach for spontaneous, *aka* interruptive, interaction. The identical representation of local, remote, and mobile colleagues in the directory of "currently online" network members makes interrupting a distant coworker as easy as interrupting someone at the next desk, increasing the likelihood of ill-timed intrusions. For instance, a coworker using a laptop computer logged onto the network to give a presentation using slides stored on a central server would appear in the "currently online" listing. Despite having taken time to update his

availability status as "busy," a coworker in another city, unaware of the presentation, might nonetheless send the presenter an IM with late-breaking and long-awaited test results as a "favor." The message would then appear on the presentation screen, to the amusement, or perhaps surprise, of the presentation audience. In another scenario, a traveling worker may be around the globe but online late to check email, a customer's website, or the train schedule for the next morning, thus appearing in the directory. A coworker, unaware of the traveler's schedule or location, might interrupt the traveler's activity by sending a spontaneous IM query rather than asking someone else, sending an email that might not be answered until the next day, or solving the problem him or herself.

The increasing prevalence of wireless networks translates, for many professional and managerial workers, into increased time online, further expanding their accessibility for interruptions. For instance, meeting attendees, taking advantage of the wireless network to read and respond to email or to search the Web or project files for meeting-relevant information, would appear in the directory, accessible to IM interruptions. A manager in a global high-tech firm, who is in meetings for a significant portion of each day, regards this capability as a "feature" because it gives his subordinates access to him when he would otherwise be inaccessible. He admits, however, that his attention to the meeting suffers (personal communication, June 2003).

IM users have several options for regulating the number and timing of interruptions. For instance, users may minimize interruptions by using the "availability status" designations available in most applications. Depending upon the "privileges" allowed by the system administrator, users may either prevent their names from appearing in the "currently online" listing for specified periods of time or may indicate their availability for receiving IMs as "available," "busy," or "do not disturb" to provide social cues to coworkers. In addition, communities of users may develop agreements regarding the "appropriate" use of the technology including content, timing, and expectations about response speed. Such social norms would likely influence both the number of messages received and the users' management of them, mitigating the number of interruptions.

Despite the opportunities for recipient control, we hypothesize that the number of interruptions will grow. Spontaneous interaction with coworkers is an essential element of collaborative work (Dabbish et al., 2003; Mintzberg, 1997; Panko, 1992; Reder and Schwab, 1990; Whittaker and Frohlich, 1994). Consequently, users will typically make themselves "available" to at least some coworkers for a significant portion of most work days. Unsolicited messages from these coworkers, despite their beneficial content, nonetheless constitute interruptions of the recipients' work. For these reasons, we expect the number of interruptions to increase rather than simply be redistributed across media. Even if recipients choose not to respond, messages "popping up" on their screens, whether flashing at the edge of the screen in the task bar or superimposed over other displays, still interrupt thought and action, even if only briefly.

> ***Proposition 6:*** IM users will experience a higher rate of interruptions than they did prior to using IM and than non-IM users in similar roles.

Interruptions and Productivity: A Heavily Moderated Relationship. Whether and when interruptions constitute *disruptions*—i.e., result in erosions of task performance and, thus,

worker productivity—represents a central question of interruption research (Gillie and Broadbent, 1989; O'Conaill and Frohlich, 1995). Researchers have linked interruptions to both negative and positive impacts on task performance (Gillie and Broadbent, 1989; O'Conaill and Frohlich, 1995; Perlow, 1997, 1999; Jett and George, 2003). In a field experiment, Perlow (1997; 1999) found that by implementing a "quiet time"—an agreement among coworkers to not interrupt one another during designated hours—three mornings a week, software developers were more efficient. They completed their assignments on time while shaving hours off the typical work day. In a very different setting, Rudolph (2001) found that interruptions experienced by medical students and physicians participating in simulated learning exercises negatively affected performance measured in terms of treatment errors and simulated patient outcomes. In addition, she found a positive correlation between the number and rate of interruptions and the magnitude of the negative effect.

In contrast, both an experimental study (Lahlou et al., 2002) and an observation study (O'Conaill and Frohlich, 1995) demonstrated that the *length of the interruption*, the interrupted *worker's mastery of the interrupted task*, and the *measures used to evaluate the effect* (i.e., personal benefit versus task completion rate) all influenced whether an interruption positively, negatively, or negligibly impacted the recipient. In fact, in an experimental study, Lahlou et al (2002) found that once a subject was trained in the task being performed, short interruptions actually facilitated, rather than hindered, performance. In a synthesis of the literature, Jett and George (2003) also note the repeated finding that interruptions facilitate workers' speed and accuracy on monotonous, routine, well-learned tasks.

Other characteristics of the interruption, including relevance to the original task, information processing demands, and timing, also seem to moderate the strength and direction of the interruption-performance relationship. Gillie and Broadbent's (1989) experiments did not reveal any relationship between interruption length and task performance, but they did show significant relationships between task performance and both the interruption's *relevance* to the original task and the complexity of its *information processing demands*. Statistically significant erosions in task performance resulted both from interruptions unrelated to the original task and from ones that required complex information processing. In addition to the content of the interruption, Cutrell et al (2001) found that the *timing* of the interruption also influenced its impact on worker performance. Interruptions occurring earlier in the completion of a task were more disruptive than those occurring toward the end of the task.

Synthesizing the extant research, we anticipate that the increased number and frequency of interruptions experienced by IM users will either positively or negatively impact recipients' productivity depending upon the nature of both the interrupted task and the interruption itself. These moderating factors include a) the recipient's familiarity with the interrupted task, b) the number and frequency of interruptions, c) the relevance of the interruption to the original task, d) the timing of the interruption in the completion of the original task, e) the complexity of the interruption's processing demands, and f) the length of the interruption. These factors are shown as moderators of the interruptions-individual productivity relationship in Figure 6.

***Proposition 7*:** Interruptive instant messages (IM) will either positively or negatively impact worker productivity depending upon the nature of both the interrupted task and the interruption.

a) Interruptive IM will have less impact on recipient productivity if the recipient is familiar with the in-progress task.
b) The greater the number and frequency of IM interruptions, the greater the negative impact on recipient productivity.
c) The more relevant the IM to the recipient's original task, the less negative the impact on productivity. Relevant messages will improve recipient productivity.
d) The closer the recipient is to the end of a task, the less negative the impact of the instant message on his/her productivity.
e) The more complex the processing demands required by an IM, the greater its negative impact on the recipient's productivity.
f) The longer the interruption, the more negative the impact on recipient productivity.

Jett and George (2003) note that the interruptions literature is characterized by a recipient bias that overly represents the negative consequences of interruptions, overlooking their functional value. While the propositions and model presented here allow for the possibility of interruptions facilitating productivity, their criticism nonetheless also applies to our argument. While Jett and George make a valuable contribution to the broader field of interruptions research, we have assumed that it is the unanticipated *negative* consequences of IM use that will be least anticipated and most problematic in organizational settings. O'Connaill and Frohlich (1995), Kraut and Attewell (1997), and Perlow (1997; 1999) have each shown that interruptions among coworkers differentially benefit the interrupter at the expense of the interrupted worker, yet it is the benefit(s) received from interrupting that perpetuate the practice (Perlow, 1997; 1999). Ironically, the benefits derived from interrupting are the "selling points" for the technology, i.e., timely access to task relevant information and coworker expertise. Consequently, we think it is the "shadow" of interruptions that most warrants explication and scrutiny.

Interruptions and Polychronic Communication. In Figure 6, we have also indicated a positive relationship between the level of interruptions and the frequency of polychronic communication. We base this assertion on our observations both of others and our personal practices reflected in our earlier descriptions of face-to-face and message queues. Left to their (our) own devices, people tend to address visitors and messages in a serial fashion according to some idiosyncratic heuristic, unless they are interrupted, in which case, they may "parallel process" or communicate polychronically in an attempt to both satisfy the interrupter and to persist with their in-progress activity. Consequently, we conclude that IM interruptions will further encourage polychronic communication.

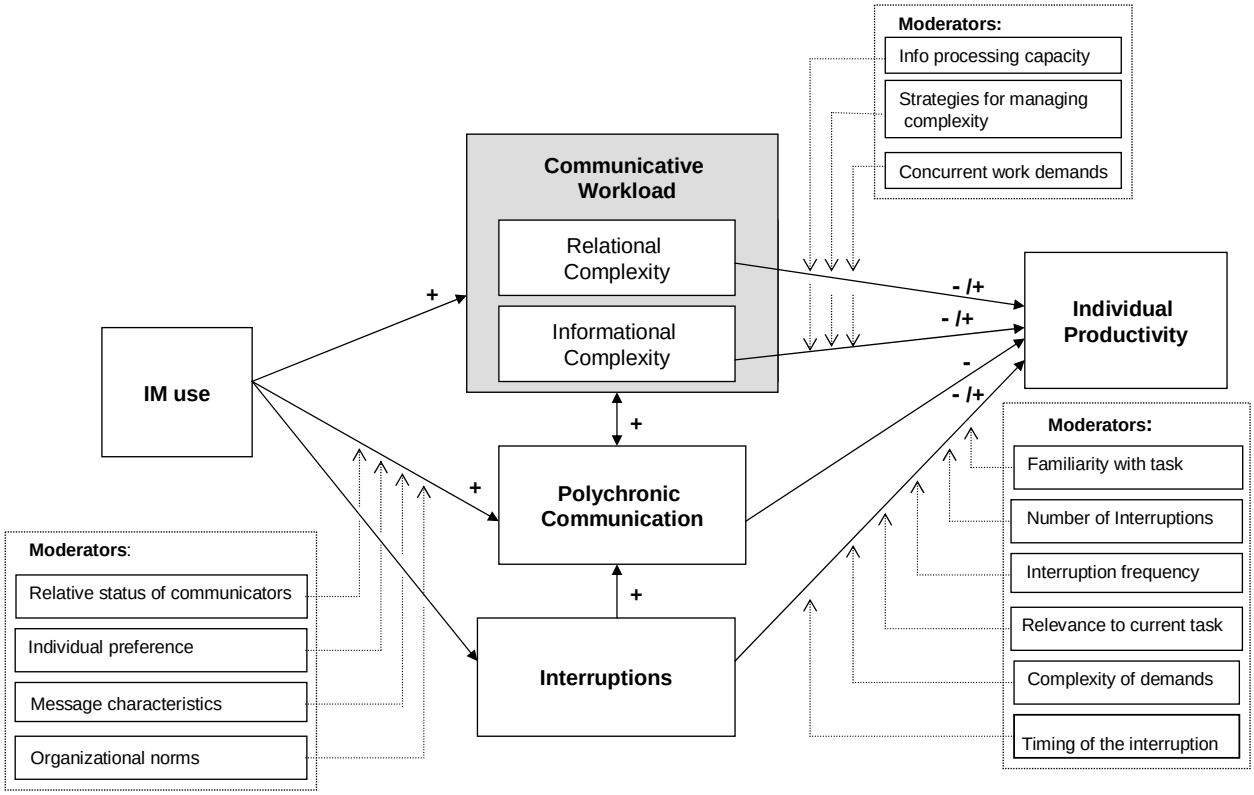

Figure 6. Consequences of IM Use for Individual Productivity Mediated Simultaneously by Communicative Workload, Polychronic Communication, and Task Interruption Effects

Proposition 8: The frequency with which IM users engage in polychronic communication will correlate positively with the number of interruptions experienced.

The relationship between IM use and individual productivity mediated by interruptions represents the third of three proposed mediated paths linking these two variables. Figure 6 shows the integration of the three mechanisms, and subsequent interactions, into a single model.

Discussion

In the preceding sections, we developed propositions, illustrated in Figure 6, regarding several potential unanticipated consequences of using instant messaging in the workplace without explicit actions to structure its use (Yates et al., 1999). We have shown that while IM use enables rapid interaction among coworkers, potentially eliminating numerous communication delays (Howarth, 2002), use of this handy technology may also have

unanticipated negative consequences for individual productivity due to increases in workers' communicative workload, engagement in polychronic communication, and the number and rate of work interruptions.

The model also suggests, however, that user actions and communicative conditions could partially mitigate these effects. Our propositions, shown as the main effects in the model, express our expectations regarding the unanticipated consequences of *unstructured* instant messaging use. Both explicit structuring—through training, policy statements, and user feedback—and implicit structuring among groups of users, however, will influence how the technology is used (Hiltz and Turoff, 1985; Orlikowski et al., 1995; Yates et al., 1999) and, thus, the impact of IM use on individual productivity. The moderating factors in each of the main effect relationships suggest several opportunities for constructive intervention. For instance, individual or group strategies for managing the increased volume and diversity of interactions (Einhorn, 1971; Hiltz and Turoff, 1985) could offset the negative impacts of an increased communicative workload despite relatively static individual information processing capabilities.

The relationship of interruptions to individual productivity is another example of an effect that could be altered or minimized through user or managerial intervention. The model indicates that interruptions by instant messages may augment as well as inhibit worker productivity. Depending upon the user's familiarity with the interrupted task and several characteristics of the interruption, the user may actually perform the original task better (Lahlou et al., 2002) after an interruption. The challenge then is to support users, both senders and receivers, in differentiating among types of interruptions (Jett and George, 2003) and timing interruptions to be the least disruptive (Dabbish and Kraut, 2003).

Hiltz and Turoff (1985) have argued that solutions to such dilemmas must be social in nature, though agreed upon social practices can be aided by technology design. Congruent with this philosophy, Dabbish and Kraut (2003) reported experiments demonstrating that most IM users acted thoughtfully when informed of how the timing of interruptions corresponds with differential productivity impacts and given a useful abstract electronic indicator of coworkers' activities and receptivity to interruptions. Though a laboratory study, the findings nonetheless suggest that a combination of user training and technology modification could prove fruitful.

We offer this framework as a starting point, anticipating that it will be refined, revised, and clarified by our own and others' empirical findings. At the same time, we expect that studies designed to investigate these propositions will also contribute to our understanding of computer-mediated communication more generally, the practice of polychronic communication, task interruptions, and how each of these affects worker performance and productivity. For instance, understanding how IM is used in organizations should, in turn, also help to establish the relevance of prior email studies as a foundation for theorizing about and designing studies of IM use. For instance, studies of email use demonstrated that access to a new electronic communication channel enabled and facilitated new communicative links between people who would not have otherwise interacted (Finholt et al., 1990; Sarbaugh-Thompson et al., 1998). Based on preliminary field observations, we assumed a similar pattern in our model of IM use and its consequences, but this relationship may or may not hold in a rigorous empirical investigation. Similarly, IM shares many of the features and affordances of text pagers and cellular telephones but also differs from these other technologies in potentially important ways (Orlikowski and Iacono, 2001). Comparing the findings of IM use studies with prior studies of email use should offer insight regarding the boundary conditions for extrapolating from study findings of one technology to another more generally.

We anticipate that understanding the value and risks of IM use will become increasingly important with the growing ubiquity of wireless technologies. Due to technological improvements, cost declines, and myriad other factors making wireless technologies more widely available (Lyytinen and Yoo, 2002), the contexts of IM use continue to expand. Increasingly, instant messaging is "bundled" into suites of applications (Fontana, 2002) available on cellular telephones, personal digital assistants (PDA), or "on-board" terminals in delivery vehicles. The uses of IM are likely to vary significantly across contexts, influenced by user location, dispersion, and mobility.

Studies designed to investigate these propositions will also contribute to the literatures drawn upon to develop them, specifically the polychronic communication and task interruptions literatures. For instance, whether or not workers use IM to communicate polychronically should contribute to our understanding of polychronic communication practices, providing a basis for either supporting or challenging Turner and Tinsley's (2002) model. Similarly, studies designed to investigate the nature and consequences of IM-related interruptions in real work contexts would provide a rich opportunity to complement a literature predominated by laboratory studies.

We also expect the implications of such research to have significant practical applications. The implementation of new technology always comes with a human consequence (Turner and Tinsley, 2002). By thoroughly examining the potential consequences of IM use, we can better anticipate how to design IM applications and manage their use such that negative performance and worklife consequences can be deterred.

Conclusions and Implications for Future Research

Both prior research (Majchrzak et al., 2000; Orlikowski, 1991) and philosophical reflections (Schiller, 1976) suggest that changes in communication medium use have broader, often unintended, social impacts, which may or may not be considered advantageous. The widespread use of instant messaging applications in organizations is a relatively new communicative phenomenon so the short and long-term consequences of its use remain empirical questions. The propositions put forth in this paper and summarized in Figure 6 offer a framework for studying the impact of IM use on individual productivity, one portion of a larger social phenomenon.

In developing this model, we have adopted an individual level of analysis and assumed a particular context of use—individuals working semi-autonomously using instant messaging to seek information needed to complete their individual tasks from other semi-autonomous workers. It is possible to imagine IM being used in other very different contexts where these assumptions would not be expected to hold. For instance, a team working collaboratively on a single project or set of related projects based on similar information might experience more synergies than constraints from IM use (Isaacs et al., 2002). The communicative workload would probably be more similar to that of a collocated team, and the interruptions would be more likely to be relevant and helpful to one's own work.

In focusing on the potential unanticipated consequences of unstructured instant message use, we have effectively excluded from our analysis and model other questions of interest with respect to IM use in organizations. Specifically, we have not considered questions of media choice (Daft et al., 1987; Markus, 1994; Trevino et al., 1987; Webster and Trevino, 1995) and technology adoption (Cooper, 1990; Dishaw and Strong, 1999), e.g., the factors influencing

whether, when, and for what purposes workers would use instant messaging relative to other communication technologies. Nor do we explore the magnitude and implications of the intended benefits of IM. While we consider this an interesting area for study, we assert that the unanticipated negative consequences of technologies in use (Orlikowski, 2000) most warrant attention in order to bring them to the fore earlier rather than later in the life of the technology. Once communicative practices become institutionalized, they become more difficult to change (Giddens, 1984; Orlikowski and Yates, 1994).

Early studies of IM use suggest this will be a fruitful area of inquiry. We hope this paper and the proposed model have evoked new questions and opened new directions for further research.

References

Ashforth, B. and Mael, F. (1989). Social Identity Theory and the Organization. *Academy of Management Review*, 14: 20-39.

Bluedorn, A. C. and Kallaith, T. J. (1999). Polychronicity and the Inventory of Polychronic Values (IVP): The development of an instrument to measure a fundamental dimension of organizational culture. *Journal of Managerial Psychology*, 14(3/4): 205-230.

Bluedorn, A. C. (2000). Time and Organizational Culture. In N. NAshkanasy and C. Wilderom and M. Peterson (Eds.), *Handbook of Organizational Culture and Climate*. Thousand Oaks, CA: Sage.

Bluedorn, A. C. (2002). *The human organization of time: Temporal realities and experience*. Stanford, CA: Stanford University Press.

Brodt, S. E., DeSanctis, G., and Emery, J. D. (2002). Beyond Messages: The Effects of Informational and Relational Complexity on E-Communication Overload. Paper presented at the Academy of Management Meeting, Denver.

Cain, M. (2002). META Report: The Future of Instant Messaging; *http://www.cioupdate.com/research/article.php/1023321;* (29 April, 2002).

Callaghan, D. (2002). E-mail, IM archiving faces rising regulatory demands. *eEweek*, 19(32): 12-13.

Cameron, A. F. and Webster, J. (2003). Instant Messaging Systems in Corporate Environments. Paper presented at the ASAC, Halifax, Nova Scotia.

Caplan, J. and Willmott, D. (2001). Inside Instant-Messaging. *Yahoo! Internet Life*, 7(11): 108-111.

Carpenter, P. A., Just, M. A., and Reichle, E. D. (2000). Working memory and executive function: Evidence from neuroimaging. *Current Opinion in Neurobiology*, 10: 195-199.

Castelluccio, M. (1999). E-mail in real time. Strategic Finance, 81(3): 34-38.

Cecez-Kecmanovic, D., Moodie, D., Busuttil, A., and Plesman, F. (1999). Organisational change mediated by e-mail and Intranet. *Information Technology and People, 12*(1), 9-26.

Chen, C. Y. (2003). The IM Invasion. *Fortune*, 147(10): 135-138.

Constant, D., Sproull, L., and Kiesler, S. (1996). The kindness of strangers: The usefulness of electronic weak ties for technical advice. *Organization Science*, 7(2): 119-135.

Cooper, R. and Zmud, R. (1990). Information Technology Implementation Research: A Technological Diffusion Approach. *Management Science*, 36(2): 123-139.

Cutrell, E., Czerwinski, M., and Horvitz, E. (2001). Notification, Disruption, and Memory: Effects of Messaging Interruptions on Memory and Performance. Paper presented at the Human-Computer Interaction--Interact '01, Tokyo.

Dabbish, L. and Kraut, R. (2003). Awareness Displays and Interruptions in Teams. Paper presented at the Annual Meeting of the Academy of Management, Seattle.

Daft, R. L., Lengel, R. H., and Trevino, L. K. (1987). Message equivocality, media selection, and manager performance: Implications for information systems. *MIS Quarterly, 11*, 355-368.

Davis, G. (2002). Anytime/Anyplace Computing and the Future of Knowledge Work. *Communications of the ACM*, 45(12): 67-73.

Dishaw, M. T. and Strong, D. M. (1999). Extending the technology acceptance model with task-technology fit constructs. *Information and Management*, 36: 9-21.

Dunlop, C., and Kling, R. (1991). *Computerization and Controversy*. Boston: Academic Press.

Economist. (2002). Instant Messaging joins the firm. *Economist*, 363(8278): 5-7.

Edmunds, A. and Morris, A. (2000). The problem of information overload in business organisations: A review of the literature. *International Journal of Information Management*, 20: 17-28.

Einhorn, H. J. (1971). Use of Nonlinear, Noncompensatory Models as a Function of Task and Amount of Information. *Organizational Behavior and Human Performance, 6*, 1-27.

Finholt, T., and Sproull, L. S. (1990). Electronic Groups at Work. *Organization Science, 1*(1), 41-64.

Fontana, J. (2002). Biz users prep for IM onslaught. *Network World*, November 18, pp. 1.

Gergen, K. J. (1991). *The Saturated Self: Dilemmas of Identity in Contemporary Life*. New York, NY: Basic Books.

Giddens, A. (1984). *The Constitution of Society*. Berkeley, CA: University of California Press.

Gillie, T., and Broadbent, D. (1989). What makes interruptions disruptive? A study of length, similarity, and complexity. *Psychological Research, 50*, 243-250.

Griffith, A. (2002). Beyond Chat - Business Uses of IM Technologies. Software and Information Industry Association internal whitepaper, January.

Henry, S. (2002). The Instant-Mess Age. *Post-Newsweek Business Information*, July 21.

Hiltz, S. R., and Turoff, M. (1985). Structuring computer-mediated communication systems to avoid information overload. *Communications of the ACM, 28*(7), 680-689.

Hiltz, S. R., and Turoff, M. (1993). *The Network Nation: Human Communication Via Computer* (Revised Edition ed.). Cambridge, MA: MIT Press.

Howarth, B. (2002). Instant Messaging Catches On. *Business Review Weekly,* August 15, pp. 78.

Isaacs, E., Walendowski, A., Whittaker, S., Schiano, D. J., and Kamm, C. (2002). The Character, Functions, and Styles of Instant Messaging in the Workplace. Paper presented at the Computer-Supported Cooperative Work, New Orleans.

Jett, Q. R. and George, J. (2003). Work Interrupted: A Closer Look at the Role of Interruptions in Organizational Life. *Academy of Management Review*, 28(3): 494-507.

Jupiter Media Metrix (2001) Total Time Spent Using Instant Messaging Jumps 110 Percent At Work And 48 Percent At Home Versus Last Year; *http://www.dienekis.com/crm-news/EppyZlpEuFoR.php*; downloaded May 6.

Just, M. A., Carpenter, P. A., Keller, T. A., Emery, L., and Zajac, H. (2001). Interdependence of Nonoverlapping Cortical Systems in Dual Cognitive Tasks. *NeuroImage*, 14(2): 417-426.

Kock, N. (2000). Information Overload and Worker Performance: A Process-Centered View. *Knowledge and Process Management*, 7(4): 256-264.

Kramer, A., and Spinks, J. (1991). Capacity Views of Human Information Processing. In J. R. Jennings and M. G. H. Coles (Eds.), *Handbook of Cognitive Psychophysiology: Central and Autonomic Nervous System Approaches* (pp. 179-249). London: John Wiley and Sons, Ltd.

Kraut, R. E. and Attewell, P. (1997). Media use in a global corporation: Electronic mail and organizational knowledge. In S. Kiesler (Ed.), *Culture of the Internet*: 323-342. Mahwah, NJ: Lawrence Erlbaum Associates.

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukopadhyay, T., and Scherlis, W. (1998). Internet Paradox: A Social Technology that Reduces Social Involvement and Psychological Well-Being? *American Psychologist*, 53(9): 1017-1031.

Lahlou, S., Kirsh, D., Rebotier, T., Reeves, C., and Remy, M. (2002). Experimental Study of the Effect of Interruption on Office Work. Unpublished manuscript, *http://adrenaline.ucsd.edu/edf/Experiment1.htm* (24 October, 2002.).

Lyytinen, K., and Yoo, Y. (2002). Research Commentary: The Next Wave of Nomadic Computing. *Information Systems Research, 13*(4), 377-388.

Majchrzak, A., Rice, R. E., Malhotra, A., King, N., and Ba, S. (2000). Technology adaptation: The case of a computer-supported inter-organizational virtual team. *MIS Quarterly, 24*(4), 569-600.

Markus, M. L. (1994). Electronic mail as the medium of managerial choice. *Organization Science, 5*(4), 502-527.

Mick, D., and Fournier, S. (1998). Paradoxes of technology: Consumer cognizance, emotions, and coping strategies. *Journal of Consumer Research, 25*, 123-143.

Miller, G. A. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. *The Psychological Review, 63*, 81-97.

Mintzberg, H. (1997). The Manager's Job: Folklore and Fact. In R. P. Vecchio (Ed.), *Leadership: Understanding the Dynamics of Power and Influence in Organizations*: 35-53. Notre Dame, IN: University of Notre Dame Press.

Nardi, B. A., Whittaker, S., and Bradner, E. (2000). Interaction and Outeraction: Instant Messaging in Action. Paper presented at the CSCW, New Orleans.

O'Conaill, B. and Frohlich, D. (1995). Timespace in the Workplace: Dealing with interruptions. Paper presented at the CHI Proceedings, Short papers, http://www.acm.org/sigchi/chi95/proceedings/shortppr/boc_bdy.htm.

Olson, G. M. and Olson, J. S. (2003). Human-Computer Interaction: Psychological Aspects of the Human Use of Computing, *Annual Review of Psychology*, Vol. 54: 491-516.

Orlikowski, W. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, *11*(4), 404-428.

Orlikowski, W. J. (1991). Intergrated information environment or matrix of control? The contradictory implicaitons of information technology. *Accounting, Organizations and Society, 1*(1), 9-42.

Orlikowski, W. J., and Gash, D. C. (1994). Technological frames: making sense of information technology in organizations. *ACM Transactions on Information Systems, 12*(2), 174 - 207.

Orlikowski, W. J., and Iacono, C. S. (2001). Research commentary: Desperately seeking "IT" in IT research - A call to theorizing the IT artifact. *Information Systems Research , 12*(2), 121-134.

Orlikowski, W. and Yates, J. (1994). Genre Repertoire: Examining the Structuring of Communicative Practices in Organizations. *Administrative Science Quarterly*, 39(4): 541-574.

Orlikowski, W., Yates, J., Okamura, K., and Fujimoto, M. (1995). Shaping Electronic Communication: The Metastructuring of Technology in the Context of Use. *Organization Science*, 6(4): 423-444.

Panko, R. R. (1992). Managerial Communication Patterns. *Journal of Organizational Computing*, 2: 95-122.

Perlin, N. E. (2003). Instant Messaging--*Another* Format to Worry About? *intercom*, January, pp. 36-37.

Perlow, L. A. (1997). *Finding Time: How corporations, individuals, and families can benefit from new work practices*. Ithaca, NY: ILR Press.

Perlow, L. (1999). The Time Famine: Toward a Sociology of Work Time. *Administrative Science Quarterly*, 44(1): 57-81.

Pickering, J. M. and King, J. L. (1995). Hardwiring Weak Ties: Interorganizational Computer-mediated Communication, Occupational Communitieis, and Organizational Change. *Organization Science*, 6(4): 479-486.

Poe, R. (2001). Instant Messaging Goes to Work; *http://www.business2.com/articles/mag/0,1640,14845,FF.html*; downloaded May 6.

PR Newswire. (2002). Instant Messaging, June 17.

Reder, S. and Schwab, R. G. (1988). The Communicative Economy of the Workgroup: Multi-Channel Genres of Communication. Paper presented at the CSCW.

Reder, S. and Schwab, R. G. (1990). The temporal structure of cooperative activity. Paper presented at the Proceedings of the conference on Computer-supported cooperative work, Los Angeles, California, United States.

Rouse, W. B. (1975). Design of man-computer interfaces for on-line interactive systems. *Proceedings of the IEEE,* 63(6): 847-857.

Rubinstein, J. S., Meyer, D. E., and Evans, J. E. (2001). Executive Control of Cognitive Processes in Task Switching. *Journal of Experimental Psychology--Human Perception and Performance*, 27(4): 763-797.

Rudolph, J. (2001). Unpublished doctoral dissertation, Boston College, Boston, MA.

Sarbaugh-Thompson, M., and Feldman, M. (1998). Electronic Mail and Organizational Communication: Does Saying "Hi" Really Matter? *Organization Science, 9*(6), 685-698.

Schenk, D. (1997). *Data Smog: Surviving the Information Glut.* San Francisco: Harper Edge.

Schiller, H. I. (1976). *Communication and Cultural Domination*.: M.E. Sharpe.

Shellenbarger, S. (2003). New Studies Show Pitfalls of Doing Too Much at Once, *The Wall Street Journal*, February 27.

Sproull, L. and Kiesler, S. (1986). Reducing Social Context Cues: Electronic Mail in Organizational Communication. *Management Science*, 32(11): 1492-1512.

Sproull, L., and Kiesler, S. (1991). *Connections: New Ways of Working in the Networked Organization*. Cambridge, MA: MIT Press.

Sproull, L., and Kiesler, S. (1996). Increasing Personal Connections. In R. Kling (Ed.), *Computerization and Controversy: Value conflicts and social choices* (pp. 455-475). San Diego, CA: Academic Press.

Thomas, R. (1995). *What Machines Can't Do: Politics and Technology in the Industrial Enterprise*. Berkeley: University of California Press.

Trevino, L. K., Webster, J., and Stein. (1987). Media symbolism, media richness, and media choice in organizations. *Communication Research, 14*, 553-574.

Turner, J. W., and Tinsley, C. H. (2002). Polychronic Communication: Managing Multiple Conversations at Once. Paper presented at the Academy of Management, Denver.

Webster, J., and Trevino, L. K. (1995). Rational and social theories as complementary explanations of communication media choices: Two policy-capturing studies. *Academy of Management Journal, 38*(6), 1544-1572.

Weick, K. E. (1985). Cosmos vs. chaos: Sense and nonsense in electronic contexts. *Organizational Dynamics, 14*(2), 51-64.

Whittaker, S. and Frohlich, D. (1994). Informal Workplace Communication: What is it like and how might we support it? Paper presented at the Human Factors in Computing Systems: Celebrating Interdependence.

Woods, B. (2001). IM More Popular than ever at work; *http://www.instantmessagingplanet.com/enterprise/article.php/923611;* downloaded May 6.

Yates, J., Orlikowski, W. J., and Okamura, K. (1999). Explicit and implicit structuring of genres in electronic communication: Reinforcement and change of social interaction. *Organization Science*, 83-103.

Zweig, D. and Webster, J. (2002). Where is the line between benign and invasive? An examination of psychological barriers to the acceptance of awareness monitoring systems. *Journal of Organizational Behavior*, 23: 605-633.

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