

Strong, Weak, and Latent Ties and the Impact of New Media

Caroline Haythornthwaite

Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, Champaign, Illinois, USA

This article argues that consideration of the strength of ties between communicators can help reconcile disparate results on the impact of new media on social relations. It is argued from the research literature and studies by the author that where ties are strong, communicators can influence each other to adapt and expand their use of media to support the exchanges important to their tie, but where ties are weak, communicators are dependent on common, organizationally established means of communication and protocols established by others. Due to this differential use of media, a new medium that adds means and opportunities for previously unconnected others to communicate will have positive effects on weak ties and weak-tie networks, in particular by laying an infrastructure of latent ties (ones that exist technically but have not yet been activated), and providing an opportunity for weak ties to develop and strengthen. A new medium may also have positive effects on strongly tied pairs where it adds another means of communicating and supports the communication needs and tasks of the pair. However, where a new medium replaces a former, common means of communication, the dependence of weak ties on a common medium makes weak-tie networks highly susceptible to dissolution. In contrast, strong-tie networks, with their connections via multiple relations and multiple media, can be expected to be more robust under conditions of change.

Keywords computer-mediated communication, latent ties, media use, social networks, strong ties, technology adoption, tie strength, weak ties

Received 28 February 2001; accepted 12 November 2001.

An earlier version of this article was first presented at the 34th Hawaii International Conference of System Sciences, January 2001. Thanks go to two anonymous reviewers for their comments.

Address correspondence to Caroline Haythornthwaite, Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, 501 East Daniel St., Champaign, IL 61820, USA. E-mail: haythorn@uiuc.edu; web site: <http://alexia.lis.uiuc.edu/~haythorn>.

New computer media have been portrayed in contradictory ways (Rice, 1999; Wellman et al., 1996). On the one hand, they are seen as providing a reduced cues environment that is ill-suited to emotional, expressive or complex communications, and responsible for longer decision times, anti-social flaming behaviors and decreased social involvement (Daft & Lengel, 1986; Finholt & Sproull, 1990; Fish et al., 1993; Kiesler & Sproull, 1992; Kraut et al., 1998; Lea et al., 1992). On the other hand, new media are seen as integrative, connecting disparate others (Constant et al., 1996; Feldman, 1987; Pickering & King, 1995), increasing the involvement of peripheral players (Eveland & Bikson, 1988; Sproull & Kiesler, 1986, 1991), consolidating existing connections (Lind & Zmud, 1995), and supporting rich online communities (Jones, 1995, 1998; Kiesler, 1997; Smith & Kollock, 1999; Sudweeks et al., 1997). These contradictions make it difficult to assess the impact of new media, and to plan for its implementation and use. The emphasis on explanations about the impact of electronic media alone often fails to consider that medium in its context, along with more traditional media and face-to-face communications, and the needs and tasks of communicators. Although researchers in communication technology have put forward theories of media use, there is still a need for theories that provide a “framework for synthesis and integration of empirical findings” (Steinfeld & Fulk, 1990, p. 13).

This article argues that viewing these results from the perspective of the strength and nature of the social network tie between communicators can help integrate and synthesize these disparate findings, as well as the use of both electronic and nonelectronic means of communication. The main argument of this article is that the use and impacts of media are dependent on the type of tie connecting communicators. The tie determines the ways, means, and expression of communications, and it determines the motivation, needs, and desires for communication. This perspective begins with the social network tie between communicators and the way in which they

use all means of communication. This is in contrast to theories that suggest it is the attributes of the media, or individual's attitudes to media that determine interaction content, and to approaches that examine the use of a single or even a subset of media to explain communication behaviors. It is in agreement with approaches that suggest an emphasis on communication practices and the way in which "communication technologies are likely to support multiple organizing processes that depend on context and change over time" (Orlikowski & Yates, 1994, p. 572).

Drawing on the research literature and results from studies by the author, it is further argued that the linear phenomenon of the strength of interpersonal ties gives rise to nonlinear impacts on the adoption and use of new media, and on their impact as connectors or disconnectors. The social network literature shows that as tie strength increases linearly from weak to strong, so does the motivation to communicate, the number and types of information and resources exchanged, and the amount of support communicated. Research by the author suggests that more weakly tied communicators rely on organizationally established or opportunistic means of sending or receiving communications. More strongly tied pairs branch out from an organizationally established medium, using more media to reach each other the stronger the tie.

Both positive and negative impacts can be expected as a result of this differential use of media, affecting strong and weak tie connections differently. Strong ties may be affected positively by the addition of new means of communication when that medium provides further means and opportunities for contact and acts as a complement to existing communications methods (Lind & Zmud, 1995; McKenney et al., 1992; Rice, 1992a; Rice & Case, 1983; Rice & Shook, 1990a; Sproull & Kiesler, 1991; Wellman et al., 1996). Weak ties may be affected positively when the medium expands the reach and basis for initiating and maintaining ties, providing a means through which previously unconnected individuals can now initiate contact (Constant et al., 1996; Culnan & Markus, 1987; Wellman et al., 1996). But where the introduction of the new media removes or overrides the way in which ties have been maintained in the past (e.g., from phone to e-mail, Markus, 1994a, 1994b; or from face-to-face meetings to listservs, Yates et al., 1999), the impact may be negative: removing existing connectivity and disrupting the ability for pairs to communicate.

These impacts do not stop at the level of the interpersonal tie. As ties build into networks, changes in media can also disrupt communication pathways and recast whole social networks. It is argued here that where weak ties are dependent on organizationally established media, the social networks their ties describe are particularly susceptible to dissolution given a change in that medium, or even

a change in organizational mandate regarding its use (e.g., Markus, 1994a, 1994b). In contrast, strong tie networks, with their use of multiple media, retain a communication path redundancy that allows the ties and the network to continue even with changes in such a medium.

This impact of tie strength on media use is most likely to be evident in outcomes associated with the introduction of a new medium, particularly when that new medium replaces an existing widely established means of communication. The use here of the phrase "new media" is not meant to imply only new forms of electronic communication, although in general that will be the concentration here. Instead, it is meant to cover the implementation of any medium that is new to the adopting unit [in keeping with Rogers's (1995) definition of an innovation]. Thus, the implementation of a new series of face-to-face meetings can be as much a "new medium" as the introduction of a chat room for group meeting and discussion. The thesis here is that it is not the characteristics of the medium that matter (such as asynchronicity or synchronicity, text or video), but the way the introduction of the medium creates a social network of ties, how its presence sustains such a network, and how its removal disrupts such a network.

THE NATURE OF SOCIAL NETWORK TIES

Before moving to a discussion of the interplay between tie strength and media use, it is useful to begin with an understanding of what it means to maintain a strong or weak tie. A tie is said to exist between communicators wherever they exchange or share resources such as goods, services, social support or information. Social network studies of offline relationships have identified a number of features that distinguish ties by strength, and which are important for understanding the interaction between tie strength and media use. Strength of a tie is normally assessed by looking at a combination of factors; frequency of contact, duration of the association, intimacy of the tie, provision of reciprocal services, and kinship have been used as measures of tie strength (for a discussion of measures of tie strength, see Marsden & Campbell, 1984). Studies find that those who report weaker, more casual, friendships or work relationships (e.g., acquaintance or coworker relationships) engage in fewer, less intimate exchanges and share fewer types of information and support than those who report stronger relationships. More strongly tied pairs include in their exchanges a higher level of intimacy, more self-disclosure, emotional as well as instrumental exchanges, reciprocity in exchanges, and more frequent interaction (Granovetter, 1982; Haythornthwaite, 1996; Marsden & Campbell, 1984; Walker et al., 1994; Wellman & Gulia, 1999; Wellman et al., 1988). Although some people maintain intimacy without frequent contact, these are primarily kinship relationships. Friends and co-workers, on the other

hand, demand a certain level of interaction and reciprocity for the relationship to be sustained (Gabarro, 1990; Walker et al., 1994). This article addresses these latter, voluntary ties rather than kinship ties.

While the number of different types of resources pairs exchange generally increases with increasing strength of the tie, the kinds of resources can differ with the type of tie. Work pairs who do not also claim a friendship tie collaborate on work, exchange work-related information, and socialize, although they do not exchange emotional support (Haythornthwaite & Wellman, 1998); neighbors provide small services, and kin provide social support (van der Poel, 1993; Wellman et al., 1988); women at work receive social support and friendship from other women, and maintain instrumental ties of communication and advice with men (Ibarra, 1992). Thus, those maintaining different kinds of ties look for opportunities to support different kinds of relations, but all look for more opportunities as their ties strengthen, and as their need or desire to communicate increases.

Any individual is likely to maintain a range of ties with others, and a range of strengths of ties with friends and coworkers across groups, organizations, and communities. For each of us, there is a continual tension between maintaining strong ties with friends or project coworkers, and weaker ties with the group as a whole, or with people outside the group (see also Haythornthwaite, 2002). There is also an ongoing ebb and flow in ties: they grow in strength as people get to know each other better, and decline as the reason for the strong association reaches its conclusion. Different strengths of ties play an important role in access to resources and our ability to get things done. Strongly tied pairs are motivated to share what information or resources they have and thus provide a ready access to information circulating their network, and a ready hand to help (Granovetter, 1982; Krackhardt, 1992; Lin & Bian, 1991). Yet their close association often leaves them with access only to the same resources as others with whom they are closely tied. Hence the "strength of weak ties" (Granovetter, 1973) is their connection to others outside the strong tie network and to the information and resources circulating in other arenas (Burt, 1992; Granovetter, 1973, 1982; McPherson & Smith-Lovin, 1987).

Although much of the emphasis in CMC research has been on the problems it can present for maintenance of strong ties and how to overcome these, many of the benefits have been associated with the maintenance of weak ties, such as inclusion and empowerment of peripheral participants. In considering the impact of new media, it is argued here that it is the presence of both strong and weak ties in an individual's, group's, organization's, and/or community's repertoire, and the ebb and flow of ties over time, that lead to differential effects in the overall picture of media use.

Thus, ties of various strengths, with their different ranges and access to resources, fill important niches in our daily work and lives. The dual usefulness of strong and weak ties begins to provide some explanation for the impacts of new media. A new medium may be useful as an additional means of contact to support strong work and social ties; and it may be useful as an easy means of contact with strangers. We see such effects in use of the Internet, as friends and family use e-mail to strengthen their ties, and as strangers use chat rooms to contact new others (see the collected papers in Haythornthwaite & Wellman, 2001; Wellman & Haythornthwaite, forthcoming). However, when the new medium replaces an important existing means of communication, perhaps as use of the Internet to communicate with remote others replaces communication with household members (e.g., Kraut et al., 1998), it is likely to have a disintegrative impact by disrupting existing ties and their resource exchanges.

Ties are defined between two people, for example, for a pair of communicators. Yet as individuals we maintain many ties with others, and they in turn hold ties with some of the same others and with some new others. The connectivity among people that exists based on all these ties describe social networks along which information and resources flow and circulate among a larger set of people. Examining the total pattern of resource exchange between pairs in a group, organization, or community, that is, between nodes or actors in the network, shows how all members of the network are interconnected, and reveals the structures that define and support the larger group (Monge & Contractor, 2000; Wasserman & Faust, 1994; Wellman & Berkowitz, 1998). In examining ties, we are examining the building blocks for networks, and any change at the tie level may have an impact at the network level.

Communication is a key way in which ties are maintained, and media enable such connection. Face-to-face meetings, social get-togethers, telephones, videoconferencing, e-mail and other computer media exist as means through which exchanges can occur, ties can be maintained, and networks can be sustained (Haythornthwaite et al., 1998; Garton et al., 1997; Rice, 1994; Wellman et al., 1996).¹ Patterns of media use, like patterns of resource exchange, can show how members of a network are connected, and how media support and create network structures. Any change or addition of media that is felt at the tie level can also be expected to be felt at the network level, as is discussed in more detail later.

ASSUMPTIONS ABOUT ONLINE TIES

Since the bulk of the research that informs our understanding of the strength of ties comes from studies of offline behaviors, it is necessary to make one important assumption

when moving from what is known about offline ties to consideration of online ties. This key assumption is that *the characteristics of ties hold in the mediated environments as they do in the offline environment*. Thus, online ties, like offline ties, are expected to be stronger to the extent that they demonstrate greater varieties of interaction and exchange, or closer to the extent that they exchange emotional support. However, no assumption of one-to-one comparability is intended; that is, it is not intended to suggest or assume that social support given once online equates with social support given once offline. Such comparability requires further study. However, it is assumed that *online exchanges are as real in terms of their impact on the tie as are offline exchanges*—for example, that social support given online is an exchange that adds to maintaining the tie, and is not neutral. Support for this position may be drawn from the many studies that find ties to flourish when supported by online information exchange, social support, work interaction, and play (Haythornthwaite et al., 2000; Jones, 1995, 1998; Kiesler, 1997; Rice & Love, 1987; Smith & Kollock, 1998; Sudweeks et al., 1997). We can also see that online exchanges are “real” by considering the impact of negative interactions, such as the effects of being flamed online, in which the impact is felt emotionally despite its online delivery and which can have a further impact on the ties among group members (e.g., see Dibbell, 1996).

In accepting the impact of both online and offline exchanges in affecting ties, it becomes difficult to separate online from offline influences on relationships. We mix face-to-face contact with e-mail, searching the Internet with asking friends and reading books, sending regular mail and e-mail with use of the telephone. Moreover, as the number of distanced work and learning teams increases, we cannot privilege face-to-face over mediated communications, and indeed for such groups, face-to-face may be the extension of online communication rather than vice versa (e.g., Haythornthwaite, 2000). Thus, to gain the measure of a tie it is necessary to consider all types of interactions between communicators, not just their online, or even just their offline, exchanges. Thus, a further assumption and position taken in this article is that *it is the tie that drives the number and types of exchanges, not whether the tie is maintained on or offline, or via any combination of the two*.

TIE STRENGTH AND MEDIA USE

There has been much research on the impact of computer media over the last 20+ years that has explored how people interact and build relationships online. What do these studies tell us already about ties, and the relation between tie strength and media use? Considering both the research on ties and on computer media, what do they suggest about

the role of strong and weak ties in forming the patterns and uses of media that we observe?

Earlier theories and approaches to computer-mediated communication (CMC) have been tacitly concerned with the types of social network relations communicators can maintain via CMC. For example, the “reduced cues” view of CMC, which underpins the theories of *social presence* (Short et al., 1976) and *media richness* (Daft & Lengel, 1986), rests on the observation that CMC allows the exchange of fewer cues than face-to-face environments. These theories led to the conclusion that CMC was less appropriate or useful for emotionally laden exchanges, for the delivery of complex information, and for creating a sense of “being there” (e.g., Fish et al., 1993; Kiesler & Sproull, 1992; Rice, 1987; Trevino et al., 1990). These conclusions are, in effect, an argument that the media cannot sustain certain kinds of exchanges, and thus certain kinds of social network relations and ties. The “richness” sought in these communications is a richness in types of exchanges: emotional and instrumental, simple and complex, verbal and nonverbal. Thus, these early theories may also be read as a concern with how CMC can be used to maintain a strong tie. This emphasis continues in the design of computer media to support working relations, such as in the efforts of designers of computer-supported cooperative work tools.

What of weak ties? One of the key benefits noted for CMC has been how it provides access to a wider range of others to whom we are weakly tied, extending communication possibilities by crossing time and space, providing means of keeping local and remote operations informed simultaneously, drawing in more peripheral participants, and providing access to a wider set of contacts (Constant et al., 1996; Feldman, 1987; Huber, 1990; Rice, 1987, 1992a, 1992b, 1999; Sproull & Kiesler, 1986, 1991; Turkle, 1995). It has been suggested that the reduced cues of CMC work to the advantage of weak ties by reducing the social risks associated with contacting unknown and unnumbered others (Sproull & Kiesler, 1986, 1991). For example, e-mail has been cited as useful for easing the difficulties strangers have in contacting individuals across hierarchical, geographical, and organizational boundaries, reducing the “social overhead” inherent in beginning a relationship (Constant et al., 1996; Feldman, 1987; Pickering & King, 1995). Both the reduced social overhead and the greater reach of CMC have made it an ideal means for initiating a tie with someone the communicator does not know well. Initiating such weak ties then has positive impacts by broadening an individual’s knowledge base, exposing them to ideas and approaches different from their own, and increasing their ability to recognize and take advantage of new opportunities (Allen, 1977; Bruffee, 1993; Cohen & Levinthal, 1990; Haythornthwaite, 2002; Koschmann, 1996).

The potential for a medium such as e-mail to be used to initiate a new contact suggests yet another level of tie, a *latent tie*: a tie for which a connection is available technically but that has not yet been activated by social interaction. Using CMC to contact previously unknown others shows how individuals can change a latent tie into a weakly active one. Latent ties can be formed by computer or noncomputer means, such as by enrollment in an organization's internal e-mail system, or by invitation to departmental, unit, or board meetings. An important characteristic of this type of tie is that it is not established by individuals. Instead it depends on structures established organizationally by management of an organization, system administrators, or community organizers (for example, when establishing community networks). Only by having this system available can latent ties exist that have the potential to be converted into weak ties, and thence perhaps to strong ties.

In noting the importance of decisions by others on the communication opportunities afforded to media users we begin to trace a connection across all strengths of ties and anticipate discussion of network level impacts of media and the development of ties over time. We return to each of these later.

Strong and Weak Tie Influences on Media Use Norms

While research still continues to design media to increase the sense of "being there," changes in communication behavior have managed to make lean, text-based media such as e-mail and listservs richer, that is, more able to carry nuance, humor, and emotion. CMC users have influenced each other to extend the capabilities of text-based media. They have incorporated variety and emotion into their exchange by developing and including emoticons and acronyms (McLaughlin et al., 1995). Listservs and news groups have achieved a critical mass of users who establish and follow CMC-specific rules of conduct, as in the way members of the "rec.arts.tv.soaps" newsgroup use subject headers to signal "spoilers" (messages that might give away the content of a television show; Baym, 1995, 1997). Work groups have come to coordinated definitions of genres, structured among themselves, that both replicate existing genres and go "beyond them to innovate with the capabilities of the new media" (Yates et al., 1997). Communicators also introduce more personal exchanges, including self-disclosure and emotional support, and CMC now sustains not only "rich" communications between pairs, but also among members of whole online communities (Cherny, 1999; Curtis, 1997; Haythornthwaite et al., 2000; Reid, 1995; Rheingold, 1993).

In this social construction of media use, i.e., its definition and redefinition according to use, patterns of exchange

and media use are constantly emerging (Contractor & Eisenberg, 1990; DeSanctis & Poole, 1994). CMC "never are technologies whose design is fixed; instead the design continues to be developed simultaneously with their implementation and use" (Lea et al., 1999, p. 300). Norms and standards of use are initiated and sustained by frequent interactors and reinforced by continued use (Clark & Brennan, 1991; Contractor & Eisenberg, 1990; DeSanctis & Poole, 1994; Fulk, 1993; Fulk & Steinfield, 1990; Yates et al., 1997).

Socially constructed norms are more likely to be established and reinforced by those with stronger ties. As more frequent communicators they are more visible (or audible) in group communications. Moreover, their greater need for variety in expression and greater motivation to communicate with each other suggests they will be more active in pursuing communication practices that meet their needs, and thus be more influential in setting group communication standards. Weakly tied pairs, with their much lower motivation to communicate, are likely to be more passive in their contact with others, for example, using an established bulletin board rather than creating one of their own, and following norms established by others. This behavior is evident in non-computer based contact in the way one may wait to talk with a casual acquaintance until copresent at a meeting or passing each other in the hallway. Earlier CMC research recognized the need to support this kind of contact among weakly tied pairs and began development of systems to support informal contact, for example, in systems designed to provide awareness of who is in hallways or in offices, and support for remote communication with them (e.g., Dourish & Bly, 1992; Fish et al., 1993; Mantei et al., 1991).

In both the passive use of existing means of communication, and in the design of systems to support informal encounters, we see again the influence of organizational decisions on communication opportunities. Placing people together physically provides the means for them to run into each other in the hallway; implementing a system designed to mimic that hallway encounter also allows them to run into each other (albeit virtually). Establishing a monthly meeting allows casual contact, as does forming an e-mail list for group communications. Thus, organizational decisions about space, colocation, meetings, and media can be seen to lay the technical infrastructure for latent ties, as well as the infrastructure for who can talk to whom, and via which means.

Strong and Weak Tie Influences on the Number of Media Used

Discussion about CMC has often revolved around trying to discover the one best medium for a particular type of communication, suggesting we choose a medium according to

the message we are trying to convey. But we do not normally partition our communications in the way. Instead we mix social greetings with work coordination, social support with information exchange. Having a stronger tie, and thus more different things to talk about, means it is more likely we will be using media for a mix of messages rather than constantly switching channels. Indeed, research shows that such pairs do not switch channels, but instead add channels and talk about all things through these channels: friends and formally tied work pairs among members of a colocated academic research group used more media to communicate than acquaintances and informally tied work pairs (Haythornthwaite & Wellman, 1998); project group members within a distance learning classes used more media to communicate with each other than with other class members (Haythornthwaite, 1999, 2001a, 2001b); and distributed scholars used more media the closer their working relationship (Koku et al., 2001). Thus, the stronger the tie, the more media communicators use to make contact with each other, perhaps to speed communication, or perhaps as different kinds of communication piggyback on each other. Strongly tied communicators may also be more successful in adding media to their repertoire or adapting it to their needs: Their greater need to communicate may lead them to seek out and jointly adopt and configure new ways to communicate (see Clark & Brennan, 1991), particularly if the medium fits a communication need not already satisfied by current media (see also Dennis & Valacich, 1999), such as adding e-mail to face-to-face meetings in order to spread contact beyond physical and temporal colocation.

By contrast, studies show that weakly tied pairs use few media to communicate with each other and often only one, and that one tends to be the medium established organizationally as the means for group-wide communication (Haythornthwaite, 2000, 2001a, 2001b; Haythornthwaite & Wellman, 1998). For example, in studies by the author of classes of distance learners, the media established for lectures [e.g., Internet Relay Chat (IRC)] and discussion [e.g., Web-based bulletin boards (Webboards)] have been found to connect all members of the class, whereas e-mail connects more selectively those with stronger work or social ties (who then use it very frequently). The combination of a technical means of communication (IRC, Webboards) and the social organization of regular real-time lectures (delivered over the Internet) and required asynchronous discussion, brought all class members together virtually and, over time, allowed activation of latent ties (Haythornthwaite, 2000, 2001a, 2001b).

Figures 1 and 2 provide an illustration from this research of these effects. Figure 1 shows the IRC networks of those who reported “working together” via this medium at each of three time periods² (1 month apart across a 15-week semester). These figures show how IRC connections

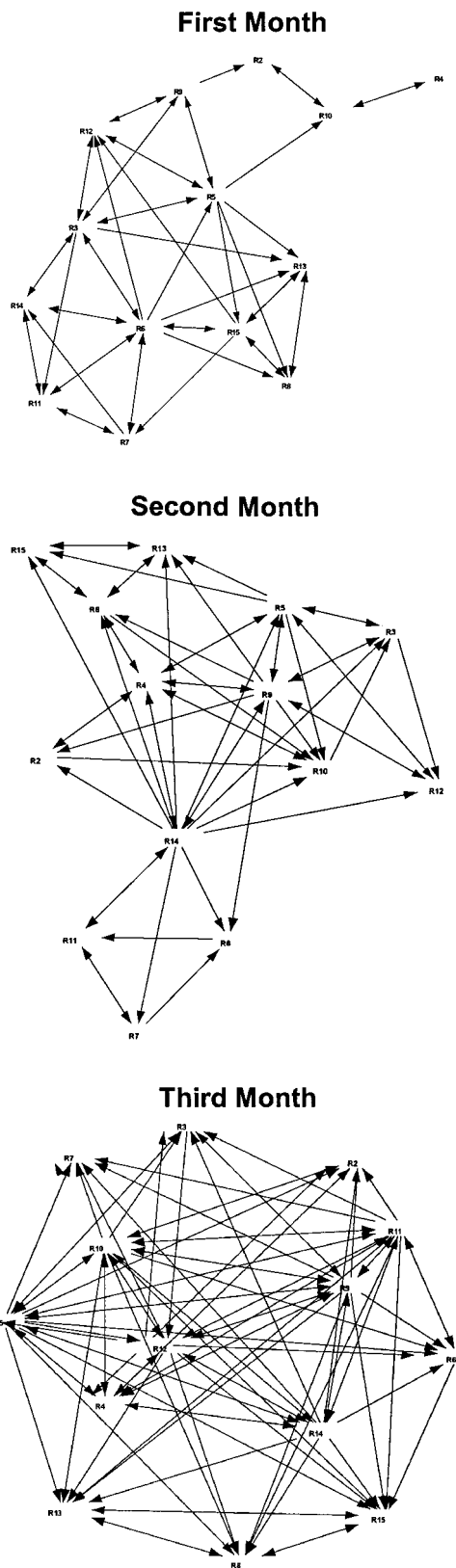
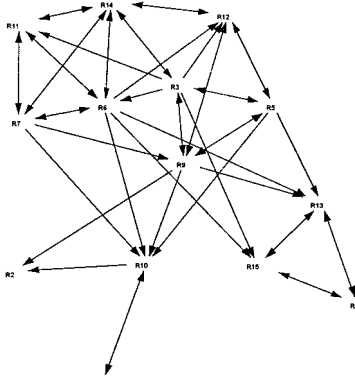
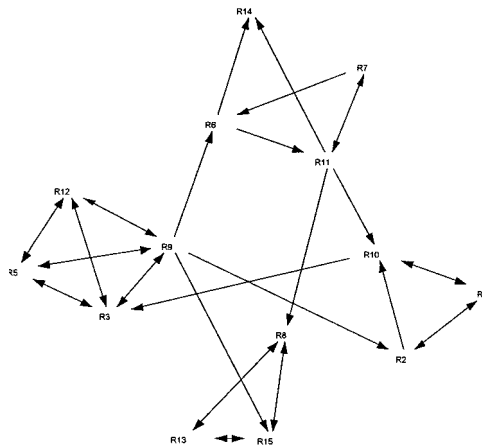


FIG. 1. IRC connections for collaborative work, monthly intervals.

First Month



Second Month



Third Month

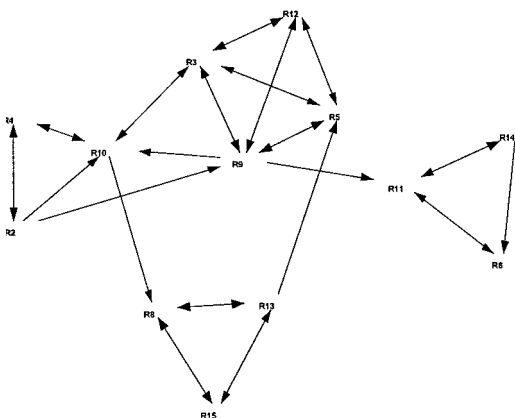


FIG. 2. E-mail connections for collaborative work at monthly intervals.

became more prominent over time in connecting the class as a whole, that is, activating some latent ties into active ties. Figure 2 shows the networks for e-mail use for the same class. E-mail use across the class begins with a pattern of connectivity similar to that for IRC, but rapidly changes into a structure that very closely resembles the project teams for the class. By time 2, patterns of e-mail use show that it has become a communication mechanism only for some members of the class: those who are more strongly tied through their work relationships. These subgroups of class members added sustained e-mail use to their “base” communication medium via IRC,³ while those without a work tie did not. [For further details on this particular class and its communication patterns, see Haythornthwaite (2001a).]

The differential use of media provides a benefit to strong ties not shared by weak ties. By using more media to communicate, and being more proactive in seeking channels for communication, strong ties are likely to be more robust under conditions of change than are weak ties. We can expect strongly tied communicators to actively and mutually renegotiate their communication pathways if one means of communication disappears. The downside for weak ties is that ties maintained via one medium are susceptible to change in that medium, and they are likely to be slow to reformulate communication links. For example, weak ties sustained through unscheduled face-to-face contact can be disrupted by reorganization of a physical office layout; weak ties sustained through an electronic bulletin board can be disrupted if the bulletin board is no longer supported, either technically or socially. An example of the latter can also be drawn from the networks of distance learners from a different class. In this second class, the Webboard was used at the beginning of the semester for discussion, but use of this medium proved to be counterproductive. Discussion was brought into IRC during regularly scheduled sessions and use of the Webboard was abandoned. Figure 3 shows how communication via the Webboard reduced markedly once its organizational use was removed. Although the technical means for communication remained, communication for the purposes of this class moved to IRC. Although a few pairs used the Webboards after time 1, its use stands in marked contrast to use by classes in which the Webboard remained part of class requirements and in which contact via the Webboard was widespread (see Haythornthwaite, 2000).

The students in the class that abandoned the Webboard were directed to other media for communication. However, if a medium is removed without such redirection, weakly tied communicators are left with no one in their (former) communication space. Given their weak connection to others, they are unlikely to try to seek out other means of communication, and unlikely to lobby organizationally for creation of a new forum for their weak-tie

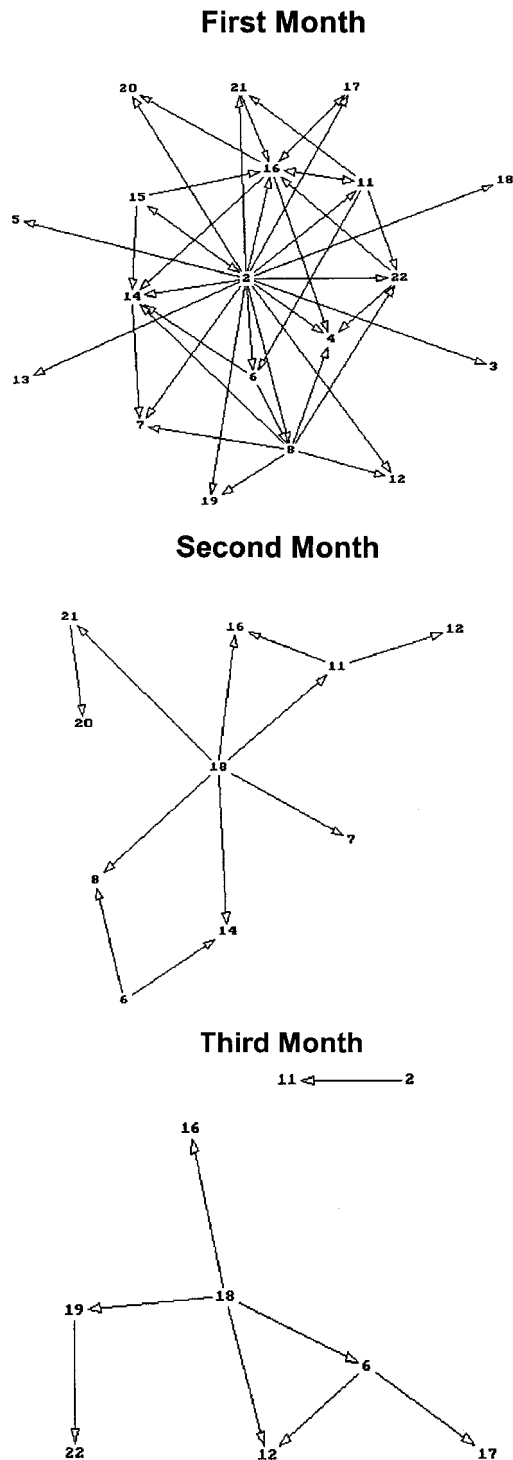


FIG. 3. Webboard connections for any type of communication, at monthly intervals.

contact. They may wait for organizational intervention to reestablish their links to others, and may never be reconnected again. In this way, a complete structure of weak tie contact can be disrupted by a change in such a medium.

INDIVIDUAL BEHAVIORS VERSUS TIE BEHAVIORS

This discussion focuses on ties between a pair of communicators, connections that when strung together form the social networks in which these communicators operate. However, this focus should not be confused with the perspective of an individual's behavior. As noted earlier, each person has many ties that range from latent to very strong. In individuals' repertoires there may be those with whom they are technically connected but have no active contact, some with whom they communicate occasionally through one or at most two media, some they work with and communicate with frequently via several channels, and some they work and socialize with, using many channels and every opportunity.

This array of relationships that make up an individual's communication landscape makes it important to examine the tie structure when examining media use. Asking individuals if they use a particular medium cannot tease out its use with everyone from its use with close friends and coworkers; 100% yes answers about media use do not mean 100% network connectivity via that medium. Similarly, when looking at the introduction of a new medium, individuals may decide to adopt it for use only with particular others. If they choose to use it only with those with whom they are strongly tied, again, they will report using the medium, and 100% yes answers about media adoption may correspond to very sparse networks.

WHICH MEDIA?

In choosing and implementing media it is important to know which media will be more likely to support the work to be done. Thus, we still need to ask: Which media? However, the question can be rephrased to ask: Which media will best support weak and strong ties? What impact do changes in media have on these ties and on the networks they form? In what follows, we address the question of "Which media?" by looking not at which particular medium we should use, but rather at what niches exist that a medium can fill. Since we have already described how weak ties tend to use only one medium to support their tie while strong use more, we begin at the weak end of the spectrum and examine what media support weak ties.

Media for Weak Ties

To support a group-wide network of weakly tied pairs—whether that "group" is a work team, department, organization, or community—requires a means of communication that connects all or nearly all participants. However, we cannot say that because it is e-mail that connects

these pairs in one setting, it will be e-mail in another, or that because it is e-mail that has provided that function in the past, it will still be e-mail as new media are deployed. The actual medium will depend on local conditions, such as accepted patterns of use, technical features, and reach and inclusiveness of the contact mechanism.

As already noted, since weakly tied pairs are not highly motivated to engage with each other and do not communicate frequently enough to establish their own group-wide patterns of behavior, the medium that serves to connect them is likely to be established by others. Traditionally, regular, scheduled face-to-face meetings have provided the opportunity for group-wide contact. Such meetings are called and organized by management rather than group members. But as organizations make greater use of CMC and of distributed workers, new means of maintaining group-wide ties have become common. For example, in an organization studied by Yates et al. (1999), regular face-to-face meetings were replaced by bulletin boards for group-wide communications; and in educational settings, distance learning programs have replaced face-to-face classes with online classes conducted through CMC (Harasim et al., 1995).

Group-wide contact mechanisms that fit this description have been found by the author in a colocated academic research group, and in classes of distance learners. The medium itself varied, but in each case it was established by authorities beyond the group members. Scheduled meetings established for classes and research meetings, and unscheduled meetings occurring due to co-location of offices were important for the academic research group even with widespread access to e-mail and telephones both in the offices and at home (Haythornthwaite & Wellman, 1998). Webboards for discussion and assignments served as the main contact medium among all class members for three of four classes, closely followed by Internet Relay Chat used during real-time lectures; weak ties among members of a fourth class were supported through weekly IRC sessions after the use of the Webboard was dropped early in the semester. In each case, class-mandated media connected the most weakly tied pairs, even though e-mail and telephones were also available for communication (Haythornthwaite, 2000, 2001a, 2001b).

Establishing a technical network is not all that is needed to achieve activation of that network. The latent ties established by the network may always lie dormant if there is not some social implementation that effects tie initiation. Thus, ties between members of a department may not be activated until a group meeting occurs; a group e-mail list may not effect wide connections until there is some requirement for placing communications on the list. Thus, a technical implementation needs to be matched with a social implementation in order to effect connection among as yet unconnected others, and to gain a critical mass of com-

munications and users so that connectivity is perceived to exist.

Media for Strong Ties

What media are the strongly tied pairs likely to use? Such pairs have the organizationally established medium available, and their desire to communicate would suggest that they would use it and, if there are no other means of communication, manipulate its use to serve their needs. Results from a study of a colocated research group (Haythornthwaite & Wellman, 1998) and from two classes of distance learners (Haythornthwaite, 2001b) show evidence that pairs add media to their repertoire in an ordered sequence according to tie strength, starting with the group-wide medium and then adding other media. Guttman scaling of the use of media in each of these environments showed conformity to a unidimensional scale, starting with the organization-wide medium, then adding more optional media. Among the colocated researchers the scale showed media to be added in this order: unscheduled face-to-face meetings, scheduled meetings, e-mail, and then "other" media (telephone, videoconferencing, fax), with the latter category used only by the most strongly tied communicators [Guttman coefficient of reproducibility (CR) .92, indicating 8% error in conformity to the scale; accepting a cutoff of 10% error as confirming the presence of a unidimensional scale, McIver & Carmines, 1981]. In the class shown in Figures 1 and 2, the order of media was IRC, Webboard, e-mail, and then the telephone (CR, .99). For the class shown in Figure 3, media use conformed to a unidimensional scale only for the ordering of IRC, e-mail, and telephone (CR, .94)—that is, excluding Webboard use.

When there are no more media for expansion, then change may be expected in the way media are used. For example, in each of four classes of distance learners, e-mail exchanges and infrequent telephone use were added to the class-mandated media by those with stronger ties, but communication via e-mail was markedly more frequent among the more strongly tied pairs (Haythornthwaite, 2000). Similarly, those reporting a close friendship among members of the colocated academic research team also show markedly higher e-mail use (Haythornthwaite & Wellman, 1998). Thus, after adopting certain media, changes in use may be expected, particularly among strongly tied pairs and perhaps also when the medium particularly suits their needs.

Which media will suit the needs of communicators, and which they will add to their repertoire, can be expected to depend on several aspects of their relationships: the exchanges that make up their tie, the time allotted for their tasks and their association, their mutual schedules, and the stage of development of their relationships. Recalling that different ties are based on different relations even

though the number and types of relations are expected to increase linearly with tie strength, we can see that as one group forms around relations of one type, another group may form around different relations. To support this network of ties, each group will seek out media to support its own needs, such as media to support work tasks among co-workers, socializing among friends, and advice from mentors. Thus, a group is unlikely to add a text-based medium when its need is for diagrams, or a voice-based medium when its need is for formal written recordings.

Time schedules associated with communication and task completion needs will also have a great impact on the suitability and usefulness of various media. Time-limited groups with approaching deadlines are unlikely to opt for a slow supplementary means of communication; those who need daily contact are unlikely to be adequately served by weekly meetings and can be expected to adopt as supplemental media ad hoc face-to-face meetings that provide immediate feedback, or e-mail exchanges that provide the convenience of asynchronous communication.

Differences may also be evident according to the life cycle of the group. When groups newly form, or individuals just meet, their number and types of relations will be few. We discuss this impact on media use next.

DEVELOPMENT OF TIES OVER TIME

The discussion so far has considered ties in stasis, that is, strong and seeking to stay that way, or weak and not seeking a change. However, ties are often in flux, particularly ties created and sustained around temporary work projects. Members of such groups come together for a limited time period during which they learn to work together, provide each other with work support and possibly emotional support, and achieve their goals. While much of the research on work groups and computer support for work groups stresses the support of strong working relations focused on the completion of tasks and the attainment of group goals, a group is not singularly task focused. McGrath (1984) describes groups as continuously engaging in production (task related), member support, and group well-being. Thus, within their work context, successful groups must come together and develop strong, multiplex ties, ones that include instrumental task-related behaviors as well as socioemotional support behaviors.

Since groups rarely come together fully formed, their initial tasks include developing their ties and communication norms. Time-limited work groups demonstrate phases of coming together, resolving crises, refocusing, completing tasks and dissolving the group (Chidambaram & Bostrom, 1997a; Gersick, 1988, 1989; McGrath, 1990, 1991; McGrath & Hollingshead, 1994). Each of these phases can have implications for media use [as argued by Chidambaram and Bostrom (1997b) regarding the use

of group decision support systems], but they can also be seen as phases in the development of social ties, which it is argued here also has implications for media use. Members of both ongoing and time-limited groups engage in a constant building and rebuilding of work and social ties; over time, ties are reinforced and renegotiated as exchanges are reciprocated or not, and as support and emotional relations are added or dropped. When subgroups form to complete work, ties are strengthened as sets of pairs increase the variety and frequency of their interactions. These may form again as one part of a project is completed and another begun.

At the same time that intragroup ties are being constantly negotiated, conventions of group behavior and use of technology are emerging through discussion and actual use (Contractor & Eisenberg, 1990; Fulk et al., 1990; DeSanctis & Poole, 1994). It has been suggested that computer-mediated groups may be slow at group development because of the reduced cues of the CMC environment (Walther, 1995). This can have serious impacts on computer-mediated, time-limited groups, who often have to complete their tasks with the same kind of schedule as face-to-face groups. Such groups may have to make the extra effort to compensate for their environment; they must sustain a high motivation toward their goals. Thus, students in computer-mediated distance courses report that they must expend more effort to maintain ties at a distance than they feel they would need in a face-to-face environment (Haythornthwaite et al., 2000).

From a tie perspective, we can also view the problem of group formation as the problem of individuals working against their normal tendencies toward weak ties. Time-limited groups who come together as weakly tied pairs need to expend effort normally reserved for strong ties, such as frequent communication, self-disclosure, and negotiation of communication norms. Moreover, there are more others to get to know. Faced with a whole set of weak ties, effort is greater because individuals must change their normal weak-tie behavior (such as waiting for opportunities to interact) into pro-active, strong tie behavior. To convert these weak ties to strong ones—or even to sort out with whom to build a strong tie—does take more effort, partly because of the change in behavior, and partly because of the number of others with whom they must negotiate relations and media conventions.

Building these ties will be easier with more frequent contact. Continued interaction allows the development of working and friendship relations. We come to like those with whom we communicate more frequently (Festinger et al., 1950), and we include more social communications over time even via CMC (Walther et al., 1994; Walther, 1995). Thus, we are more likely to develop stronger ties with those with whom we have more continuous opportunities for communication. Under normal circumstances,

meeting someone daily at work will build ties faster than CMC communication. However, as Walther (1995) found, decision-making groups with continuous access to CMC showed more intimacy and sociability in their interactions than did face-to-face groups that met only three times over a 5-week period. The CMC groups also progressively increased the social versus task orientation of their communications over time, showing a growth of "relational communication," that is, communication that promotes social identity and social information exchange (Walther, 1995). Thus, it may not be so much CMC that slows group development, but infrequent contact. Again, it is necessary to look at the totality of communication and media use to understand the impact on relations and tie formation.

CMC that transcends time and space provides an ideal means for continuous, convenient connectivity, and for strengthening ties. Freeman (1984), for example, reports how the use of computer media strengthened ties among social network analysts. Freeman compared awareness and acquaintance networks of 16 researchers, approximately 7 months before the use of an electronic conferencing system, at the beginning of its use, and after 7 months of use. While pairs showed movement from awareness to acquaintance across each time period, changes were much more pronounced following the introduction of the CMC system. Although Freeman cautions that other factors could have produced these changes, it appeared most likely that the opportunity for interaction afforded by the continuous CMC contact was responsible for speeding the process of mutual acquaintance among these researchers.

Time-limited groups eventually reach a phase when their production cycle is complete and the group is dissolved. At this time the motivations for ties may disappear. Some ties may remain based on professional or friendship bonds, but others may dissolve as the motivation for interaction is removed. Ties based solely on work exchanges, however multiplex, are unlikely to survive the dissolution of their purpose unless renegotiated on the basis of a new or different purpose for existing. So, too, when the means for maintaining a tie is removed (dropping the group meetings, non-response from or deletion of a e-mail list), ties must be renegotiated via different means, or left to lapse. Ties may once more become latent, although perhaps more readily rekindled if the motivation returns, e.g., as new work groups are formed (see Nardi et al., 2000).

SUPPORT FOR ALL TIES

To summarize, the discussion and results presented suggest that an organizationally established and possibly mandated means of communication serves as a base for initiating and maintaining group-wide ties. The presence of the medium provides the very weakest of connection among group members and a means through which individuals

may activate latent ties into weak ties. The lower the overhead in terms of technical know-how⁴ or social exposure, the easier it is for individuals to use that medium to activate and maintain weak ties. More strongly tied pairs will also make use of this medium, but their greater variety and frequency of exchanges will lead them to seek out supplemental means of communication to use in addition to the base medium. A base medium may also be seen as a way to initiate weak ties that may, through more frequent interaction, develop into a stronger tie, and perhaps from there may branch out to other means of contact. Thus, the base medium serves as a potential connector of latent ties, an actual connector of group-wide weak ties, and an initiator for stronger ties.

In adding new media to the mix, there is another way in which ties and media interact. Adding a new medium may have a direct effect by improving communication processes and thus in building stronger ties. There may then be an indirect effect on the use of existing media. For example, Lind and Zmud (1995) found that a sales organization's addition of voice mail to traditional written means of communication not only produced stronger customer sales and sales manager-field representative relationships, but also resulted in an increased use of traditional media. Considering these results from the perspective of the network tie suggests that adding the new medium provided a means through which stronger ties could be created and with it a desire for more frequent communication, which was satisfied by greater use of all existing communication channels.

Resistance and Nonuse

In discussing patterns of adoption and use, it should not be forgotten that there are also patterns of resistance and nonuse. The emphasis on an organizationally established base means of communication reminds us that it is common in organizational settings for individuals to be faced with an adoption decision *after* an innovation has been chosen by others and implemented for their use (Rogers, 1995). Where a base or supplemental medium does not fit well with task and interpersonal requirements, use of the medium may be resisted or even abandoned when conditions allow it. For example, Markus (1994a, 1994b) describes an organization in which e-mail was set as the organizational standard for communication, overriding the earlier use of the telephone and face-to-face meetings. Managers imposed its use in accordance with the directive from the chief executive. However, when the executive left the company, e-mail use declined and the use of telephone and face-to-face meetings was reestablished. Similarly, Yates et al. (1999) describe an organization in which regular face-to-face meetings, which had been used as a general means of communication, were replaced by

electronic bulletin boards. One group, which they characterized as more formal than others, resisted the use of bulletin boards and remained with the face-to-face meetings for contact among their group members.

Resistance may be passive (e.g., nonuse), or active (e.g., establishing and using other means of communication). Although a medium can be imposed from outside the group, as noted above, its adoption and success depend on its being useful to communicating pairs. Tie strength may also play a role in the type of resistance such pairs enact. Nonuse is a more likely response among weakly tied pairs. Their low need to communicate, infrequent contact, and low social influence on each other makes it unlikely that they will attempt to establish other channels for communication as strongly tied pairs might. Strongly tied pairs can be expected to influence each other on which media to use and will be more able to sustain use of an alternate communication mechanism, as did the group members in the study by Yates et al. (1999). Their need and desire for contact is higher, so they will strive to establish common patterns of communication. Moreover, their ability to influence each other allows them to carry on with their established means of communication even in the face of organizational change.

FROM TIE TO NETWORK-LEVEL IMPACTS OF CHANGES IN COMMUNICATION MEDIA

A change in a base medium can be expected to have differential impact for weak and strong tie networks. As noted earlier, the dependence of all weak ties on one common medium puts that weak-tie network at risk if the medium changes. Those communicating through only the base medium become disconnected, yet they may not be motivated to reconstruct ties through a new medium. New connections may be forged as newly established latent ties are set in place by the new medium and converted into weak ties. Although a change in the base medium will be disruptive for strong ties, their use of other media makes it possible for them to continue communicating. Strongly tied pairs need only shift their communication patterns, with other channels continuing to connect them while the transition is made. Thus, changes in the base medium can be expected to have a greater impact on networks of weak ties than networks of strong ties.⁵

While the impact of the shift in networks will differ by setting, any mass reorganization of ties can be expected to have impacts on who talks to whom. Such changes have already been documented. Changes in connectivity were recognized early in studies of e-mail. Central and peripheral organization members became better connected (Eveland & Bikson, 1988; Finholt & Sproull, 1990; Huff, Sproull & Kiesler, 1989, 1991; Kiesler & Sproull, 1992; Rice, 1994). Peripheral players also became connected to

each other as e-mail allowed latent ties to become active: An employee e-mail "Gripenet" emerged, connecting formerly disconnected others in discussion of their dissatisfaction with organizational practices (Emmett, 1982); women in a large corporation came together through e-mail to form a career discussion group (Zuboff, 1988); and Israeli professors from several universities set up an e-mail network in support of their strike activities (Romm & Pliskin, 1994).

These changes in turn affect who is on the communication path between people in the network, which changes the overall communication structure, creating central figures who supply new types of information while displacing others, and forming new social networks while dissolving others (Burkhardt & Brass, 1990; Rice, 1994). For example, one type of change that has been identified as a result of the introduction of new media is a shift in power from a hierarchy of position to a hierarchy of competence (discussed by Huber, 1990, and identified by Foster & Flynn, 1984, and Burkhardt & Brass, 1990).

This differential impact of new media by tie strength also shows how adding or subtracting a particular interaction, that is, interaction via a particular medium, changes coordination among actors in the network. By subtracting interaction via a group-wide communication mechanism, ties and coordination among weakly tied pairs are dissolved, yet ties among strongly tied pairs continue. This also shows how a computer network, as a social network (Wellman et al., 1996; Wellman, 2001), can enable and disable interaction between two parties (Salancik, 1995): The introduction of a new group-wide communication mechanism can connect otherwise separated individuals (whether separated by geography, hierarchy or status), and similarly, the removal of that mechanism can disconnect otherwise weakly connected individuals.

Differential effects of the addition of new media for weak and strongly tied communicators also offer another interpretation of the debate on whether new media "replace" or "extend" communication possibilities. For weakly tied communicators, a new, group-mandated medium will indeed replace an old one, for example, shifting communications from face-to-face to e-mail or bulletin boards. The new medium may replace the existing weakly tied social network with a new one: one network is dissolved and another formed. For strongly tied communicators, a new medium is more likely to extend their communications, reinforcing the existing strong social network. Those very weakly tied pairs who depend on the use of only one medium will be the most susceptible to change. Even when the medium is not a group-mandated medium, any change in connectivity among weakly tied pairs will impact the size and composition of their network, and potentially change the overall configuration of who talks to whom within the entire network.

CONCLUSION

This article has argued that some of the conflicting results on the impact of new media can be reconciled by taking into account the strength of the social network tie between communicators. It is argued that where ties are strong, communicators will adapt their use of media to support the greater range of expression important to their relationship, and use multiple means of communication to support their tie. They will be more ready to adopt new media that suit or complement their communication needs, more able to influence each other to use and adapt it, but also more able to influence each other to resist a change when it does not suit their mutually agreed patterns of communication. On the other hand, weakly tied pairs will be more passive in their use and adoption of new media. They will depend on organizationally established and mandated means and protocols for communication, accepting the connectivity provided by such means. With their low motivation to communicate and low influence on each other's behaviors, they will be unlikely to actively resist an organizationally adopted medium, but, as individuals, may choose not to use the medium. A further range of tie is noted as important in considering the impact on media use, that is, that of a latent tie set in place by the presence of an organizationally established medium. Such a medium can provide the technical means for as-yet-unactivated, latent ties to be activated into weak-tie relationships, but such activation is more likely to happen when social implementations are also established that promote the use of the new medium. Research suggests that these group-wide, organizationally established media serve as a base on which weakly tied communicators can begin to build stronger relationships, and on which more strongly tied communicators build their media use, expanding their media repertoire to include other, supplemental means and methods of communication according to their task and interpersonal communication needs.

Bringing consideration of the strength of interpersonal ties to examination of the effects of CMC shows that tie strength, a linear phenomenon ranging from weak to strong, has a nonlinear effect on social networks supported by CMC. Weak ties, because of their reliance on passive, opportunistic means of communication, are highly susceptible to dissolution when those means are changed. Strong ties, based on many roles, relations, and media are more robust under conditions of change. The addition of new media may even further strengthen such ties since they provide new means of connecting with others, such as allowing contact outside the office or across geographic location.

The differential impacts on weak and strong ties arising from changes in media suggest a need to plan for such effects when implementing new media. To maintain con-

nectivity among both the strongly and weakly tied members of a group requires implementation of a means of communication that reaches all group members, yet requires little effort or extra work from them when receiving or contributing group-wide communications. At the same time, subgroups organized around work or other activities require more and different means of communication. Members of these more strongly tied groups require media that can be tailored to fit their specific tasks and schedules. Some evolution in use can be expected over time, particularly among strongly tied communicators as they develop norms and uses of media that accommodate their schedules and work activities. By providing multiple means of communication to groups, members can use these means to build the communication array that best serves their needs and habits.

NOTES

1. Exchanges via computer-mediated communications (CMC) are generally limited to text-based, informational resources, whether for task completion, social support, or socializing. Although the focus here is on the exchange of communication-based resources, it is likely that the kinds of exchanges that can be enacted via CMC will expand in the near future, e.g., to include exchange of goods, either directly, as in forwarding software or information products, or indirectly, as in forwarding goods acquired electronically.

2. These figures show reported interactions, not interactions captured from electronic logs. Thus, they show perceptions of interconnection with other class members rather than actual connections. Such kinds of reports have been found to be reliable for comparisons across reports of connections, and in whether a connection occurred or not, although not accurate in matching exactly how often an interaction occurred (Hartley et al., 1977; Rice & Shook, 1990b). Thus, these figures should be read for comparison across media and time rather than as measures of exact numbers of interactions.

3. This particular class also made use of Webboards for asynchronous discussion and homeworks which acted as a second base medium. Connectivity via the Webboards nears 100% at each time period (see Haythornthwaite, 2001a).

4. See also Rogers (1995) regarding the complexity of an innovation and how high-complexity innovations are slower to be adopted.

5. This argument may be applied similarly to ties themselves; for example, ties that are sustained on more than work relations will survive dissolution of a work team. Changes in a base relation (work relations) can be expected to have a greater impact on those tied only by work relations than those with a wider range of relations.

REFERENCES

- Allen, T. J. 1977. *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization*. Cambridge, MA: MIT Press.
- Baym, N. K. 1995. The emergence of community in computer-mediated communication. In *Cybersociety: Computer-mediated communication and community*, ed. S. G. Jones, pp. 138–163. Thousand Oaks, CA: Sage.

- Baym, N. K. 1997. Interpreting soap operas and creating community: Inside an electronic fan culture. In *Culture of the Internet*, ed. S. Kiesler, pp. 103–120. Mahwah, NJ: Lawrence Erlbaum Associates.
- Bruffee, K. A. 1993. *Collaborative learning: Higher education, interdependence, and the authority of knowledge*. Baltimore, MD: John Hopkins University Press.
- Burkhardt, M. E., and Brass, D. J. 1990. Changing patterns and patterns of change: The effects of a change in technology on social network structure and power. *Administrative Science Quarterly* 35(1):104–127.
- Burt, R. 1992. *Structural holes: The social structure of competition*. Cambridge, MA: Harvard University Press.
- Cherny, L. 1999. *Conversation and community: Chat in a virtual world*. Stanford, CA: CSLI.
- Chidambaram, L., and Bostrom, R. P. 1997a. Group development (I): A review & synthesis of developmental models. *Group Decision & Negotiation* 6:159–187.
- Chidambaram, L., and Bostrom, R. P. 1997b. Group development (II): Implications for GSS research and practice. *Group Decision & Negotiation* 6:231–254.
- Clark, H. H., and Brennan, S. E. 1991. Grounding in communication. In *Perspectives on socially shared cognition*, eds. L. B. Resnick, J. M. Levine, and S. D. Teasley, pp. 127–149. Washington, DC: American Psychological Association.
- Cohen, W. M., and Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35:128–152.
- Constant, D., Kiesler, S. B., and Sproull, L. S. 1996. The kindness of strangers: The usefulness of electronic weak ties for technical advice. *Organization Science* 7(2):119–135.
- Contractor, N. S., and Eisenberg, E. M. 1990. Communication networks and new media in organizations. In *Organizations and communication technology*, eds. J. Fulk and C. W. Steinfield, pp. 143–172. Newbury Park, CA: Sage.
- Culnan, M. J., and Markus, M. L. 1987. Information technologies. In *Handbook of organizational communication: An interdisciplinary perspective*, eds. F. M. Jablin, L. L. Putnam, K. H. Roberts, and L. W. Porter, pp. 420–443. Newbury Park, CA: Sage.
- Curtis, P. 1997. MUDDING: Social phenomena in text-based virtual realities. In *Culture of the Internet*, ed. S. Kiesler, pp. 121–142. Mahwah, NJ: Lawrence Erlbaum Associates.
- Daft, R. L., and Lengel, R. H. 1986. Organizational information requirements, media richness and structural design. *Management Science* 32(5):554–571.
- Dennis, A. R., and Valacich, J. S. 1999. Rethinking media richness: Toward a theory of media synchronicity. *Proceedings of the 32nd Hawaii International Conference on System Sciences*. Los Alamitos, CA: IEEE Computer Society Press.
- DeSanctis, G., and Poole, M. S. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science* 5(2):121–147.
- Dibbell, J. 1996. Taboo, consensus, and the challenge of democracy in an electronic forum. *Computerization and controversy*, ed. R. Kling, pp. 553–568. San Diego, CA: Academic Press.
- Dourish, P., and Bly, S. 1992. Portholes: Supporting awareness in a distributed work group. In *Striking a balance: Proceedings of the ACM Conference on Human Factors in Computer Systems CHI '92*, eds. P. Bauersfeld, J. Bennett, and G. Lynch, pp. 541–547. New York: ACM Press.
- Emmett, R. 1982. VNET or GRIPENET. *Datamation* 4:48–58.
- Eveland, J. D., and Bikson, T. K. 1988. Work group structures and computer support: A field experiment. *ACM Transactions on Office Information Systems* 6(4):354–379.
- Feldman, M. 1987. Electronic mail and weak ties in organizations. *Office: Technology and People* 3:83–101.
- Festinger, L., Schacter, S., and Back, K. W. 1950. *Social pressure in informal groups*. Stanford, CA: Stanford University Press.
- Finholt, T., and Sproull, L. 1990. Electronic groups at work. *Organization Science* 1(1):41–64.
- Fish, R., Kraut, R., Root, R., and Rice, R. 1993. Video as a technology for informal communication. *Communications of the ACM* 36(1):48–61.
- Foster, L. W., and Flynn, D. M. 1984. Management information technology: Its effects on organizational form and function. *Management Information Systems Quarterly* 8:229–236.
- Freeman, L. 1984. The impact of computer based communication on the social structure of an emerging scientific specialty. *Social Networks* 6:201–221.
- Fulk, J. 1993. Social construction of communication technology. *Academy of Management Journal* 36(5):921–950.
- Fulk, J., and Steinfield, C. W., eds. 1990. *Organizations and communication technology*. Newbury Park, CA: Sage.
- Fulk, J., Steinfield, C., Schmitz, J., and Power, J. G. 1990. A social influence model of technology use. In *Organizations and communication technology*, eds. J. Fulk and C. W. Steinfield, pp. 117–140. Newbury Park, CA: Sage.
- Gabarro, J. J. 1990. The development of working relationships. In *Intellectual teamwork: Social and technological foundations of cooperative work*, eds. J. Galegher, R. E. Kraut, and C. Egido, pp. 79–110. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Garton, L., and Wellman, B. 1995. Social impacts of electronic mail in organizations: A review of the research literature. *Communication Yearbook* 18:434–453.
- Garton, L., Haythornthwaite, C., and Wellman, B. 1997. Studying on-line social networks. *Journal of Computer-Mediated Communication* 3(1). (<http://207.201.161.120/jcmc/vol3/issue1/garton.html>)
- Gersick, C. 1989. Marking time: Predictable transitions in task groups. *Academy of Management Journal* 32(2):274–309.
- Gersick, C. J. G. 1988. Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal* 33(1):9–41.
- Granovetter, M. S. 1973. The strength of weak ties. *American Journal of Sociology* 78:1360–1380.
- Granovetter, M. S. 1982. The strength of weak ties: A network theory revisited. In *Social structure and network analysis*, eds. P. V. Marsden and N. Lin, pp. 105–130. Beverly Hills, CA: Sage.
- Harasim, L., Hiltz, S. R., Teles, L., and Turoff, M. 1995. *Learning networks: A field guide to teaching and learning online*. Cambridge, MA: MIT Press.
- Hartley, C., Brecht, M., Pagerly, P., Weeks, G., Chapanis, A., and Hoecker, D. 1977. Subjective time estimates of work tasks by office workers. *Journal of Occupational Psychology* 50:23–36.
- Haythornthwaite, C. 1996. Social network analysis: An approach and technique for the study of information exchange. *Library and Information Science Research* 18:323–342.

- Haythornthwaite, C. 1999. Collaborative work networks among distributed learners. *Proceedings of the 32nd Hawaii International Conference on System Sciences*. Los Alamitos, CA: IEEE Computer Society.
- Haythornthwaite, C. 2000. Online personal networks: Size, composition and media use among distance learners. *New Media and Society* 2(2):195–226.
- Haythornthwaite, C. 2001a. Exploring multiplexity: Social network structures in a computer-supported distance learning class. *The Information Society* 17(3):211–226.
- Haythornthwaite, C. 2001b. *Supporting distributed relationships: Relations and media use over time*. Paper presented at the International Communication Association conference, May, Washington, DC.
- Haythornthwaite, C. 2002. Social networks of collaborative work and media use among distributed learners. In *Building virtual communities*, eds. A. Renninger and W. Shumar, pp. 159–190. Cambridge, UK: Cambridge University Press.
- Haythornthwaite, C., Kazmer, M. M., Robins, J., and Shoemaker, S. 2000. Community development among distance learners: Temporal and technological dimensions. *Journal of Computer-Mediated Communication* 6(1). (<http://www.ascusc.org/jcmc/vol6/issue1/haythornthwaite.html>)
- Haythornthwaite, C., and Wellman, B. 1998. Work, friendship and media use for information exchange in a networked organization. *Journal of the American Society for Information Science* 46(12):1101–1114.
- Haythornthwaite, C., and Wellman, B. 2001. The Internet in everyday life. *American Behavioral Scientist*, 45(3) (whole issue).
- Haythornthwaite, C., Wellman, B., and Garton, L. 1998. Work and community via computer-mediated communication. In *Psychology of the Internet*, ed. J. Gackenbach, pp. 199–226. San Diego, CA: Academic Press.
- Huber, G. P. 1990. A theory of the effects of advanced information technologies on organizational design, intelligence, and decision making. In *Organizations and communication technology*, eds. J. Fulk and C. W. Steinfield, pp. 237–274. Newbury Park, CA: Sage.
- Huff, C., Sproull, L., and Kiesler, S. 1989. Computer communication and organizational commitment: Tracing the relationship in a city government. *Journal of Applied Social Psychology* 19:1371–1391.
- Ibarra, H. 1992. Homophily and differential returns: Sex differences in network structure and access in an advertising firm. *Administrative Science Quarterly* 37:422–447.
- Jankowski, N., Jones, S., Samarajiva, R., and Silverstone, R. 1999. Editorial. *New Media & Society* 1(1):5–9.
- Jones, S. G., ed. 1995. *CyberSociety: Computer-mediated communication and community*. Thousand Oaks, CA: Sage.
- Jones, S. G., ed. 1998. *Cybersociety 2.0: Revisiting computer-mediated communication and community*. Thousand Oaks, CA: Sage.
- Kiesler, S., ed. 1997. *Culture of the Internet*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Kiesler, S., and Sproull, L. 1992. Group decision making and communication technology. *Organization Behavior and Human Decision Processes* 52:96–123.
- Koku, E., Nazer, N., and Wellman, B. 2001. Netting scholars: Online and offline. *American Behavioral Scientist* 44(10):1752–1774.
- Koschmann, T. 1996. Paradigm shifts and instructional technology: An introduction. In *CSCL: Theory and practice of an emerging paradigm*, ed. T. Koschmann, pp. 1–23. Mahwah, NJ: Lawrence Erlbaum Associates.
- Krackhardt, D. 1992. The strength of strong ties: The importance of *philos* in organizations. In *Networks and organizations: Structure, form and action*, eds. N. Nohria and R.G. Eccles, pp. 216–239. Boston: Harvard Business School Press.
- Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukhopadhyay, T., and Scherlis, W. 1998. Internet paradox: A social technology that reduces social involvement and psychological well-being? *American Psychologist* 53(9):1017–1031.
- Lea, M., O’Shea, T., Fung, P., and Spears, R. 1992. “Flaming” in computer-mediated communication: Observations, explanations, implications. In *Contexts of computer-mediated communication*, ed. M. Lea, pp. 89–112. New York: Harvester Wheatsheaf.
- Lea, M., O’Shea, T., and Fung, P. 1995. Constructing the networked organization: Content and context in the development of electronic communication. In *Shaping organization form: Communication, connection, and community*, eds. G. DeSanctis and J. Fulk, pp. 295–324. Newbury Park, CA: Sage.
- Lin, N., and Bian, Y. 1991. Getting ahead in urban china. *American Journal of Sociology* 97(3):657–688.
- Lind, M., and Zmud, R. 1995. Improving interorganizational effectiveness through voice mail facilitation of peer-to peer relationships. *Organization Science* 6(4):445–462.
- Mantei, M., Baecker, R. M., Sellen, A. J., Buxton, W. A. S., Milligan, T., and Wellman, B. 1991. Experiences in the use of a media space. In *Reaching through technology: CHI ’91 conference proceedings*, eds. S. P. Robertson, G. M. Olson, and J. S. Olson, pp. 203–208. New York: ACM Press.
- Markus, M. L. 1994a. Finding a happy medium: Explaining the negative effects of electronic communication on social life at work. *ACM Transactions on Information Systems* 12:119–149.
- Markus, M. L. 1994b. Electronic mail as the medium of managerial choice. *Organization Science* 5:502–527.
- Marsden, P. V., and Campbell, K. E. 1984. Measuring tie strength. *Social Forces* 63:482–501.
- McGrath, J. E. 1984. *Groups, interaction and performance*. Englewood Cliffs, NJ: Prentice Hall.
- McGrath, J. E. 1990. Time matters in groups. In *Intellectual teamwork: Social and technological foundations of cooperative work*, eds. J. Galegher, R. E. Kraut, and C. Egido, pp. 23–61. Hillsdale, NJ: Lawrence Erlbaum Associates.
- McGrath, J. E. 1991. Time, interaction and performance (TIP): A theory of groups. *Small Group Research* 22(2):147–174.
- McGrath, J. E., and Hollingshead, A. B. 1994. *Groups interacting with technology*. Beverly Hills, CA: Sage.
- McIver, J. P., and Carmines, E. G. 1981. *Unidimensional scaling*. Beverly Hills, CA: Sage.
- McKenney, J. L., Zack, M. H., and Doherty, V. S. 1992. Complementary communication media: A comparison of electronic mail and face-to-face communication in a programming team. In *Networks and organizations: Structure, form, and action*, eds. N. Nohria and R. G. Eccles, pp. 262–287. Boston: Harvard Business School Press.
- McLaughlin, M. L., Osborne, K. K., and Smith, C. B. 1995. Standards of conduct on usenet. In *Cybersociety: Computer-mediated communication and community*, ed. S. G. Jones, pp. 90–111. Thousand Oaks, CA: Sage.

- McPherson, J. M., and Smith-Lovin, L. 1986. Sex segregation in voluntary associations. *American Sociological Review* 51(1):61–79.
- McPherson, J. M., and Smith-Lovin, L. 1987. Homophily in voluntary organizations: Status, distance, and the composition of face-to-face groups. *American Sociology Review* 52:370–379.
- Monge, P. R., and Contractor, N. S. 2000. Emergent communication networks. In *New handbook of organizational communication*, eds. F. M. Jablin and L. L. Putnam, pp. 440–502. Newbury Park, CA: Sage.
- Nardi, B. A., Whittaker, S., and Schwarz, H. 2000. It's not what you know, it's who you know: Work in the information age. *First Monday* 5(5). (http://www.firstmonday.dk/issues/issue5_5/nardi)
- Orlikowski, W. J., and Yates, J. 1994. Genre repertoire: The structuring of communicative practices in organizations. *Administrative Science Quarterly* 39:541–574.
- Pickering, J. M., and King, J. L. 1995. Hardwiring weak ties: Interorganizational computer-mediated communication, occupational communities, and organizational change. *Organization Science* 6(4):479–486.
- Poole, M. S., and DeSanctis, G. 1990. Understanding the use of group decision support systems: The theory of adaptive structuration. In *Organizations and communication technology*, eds. J. Fulk and C. W. Steinfield, pp. 173–193. Newbury Park, CA: Sage.
- Reid, E. 1995. Virtual worlds: Culture and imagination. In *Cybersociety: Computer-mediated communication and community*, ed. S. G. Jones, pp. 164–183. Thousand Oaks, CA: Sage.
- Rheingold, H. 1993. *The virtual community: Homesteading on the electronic frontier*. Reading, MA: Addison-Wesley.
- Rice, R. E. 1987. Computer mediated communication and organizational innovation. *Journal of Communication* 37(4):65–94.
- Rice, R. E. 1992a. Task analyzability, use of new media, and effectiveness: A multi-site exploration of media richness. *Organization Science* 3(4):475–500.
- Rice, R. E. 1992b. Contexts of research on organizational computer-mediated communication. In *Contexts of computer-mediated communication*, ed. M. Lea, pp. 113–144. New York: Harvester Wheatsheaf.
- Rice, R. E. 1994. Network analysis and computer-mediated communication systems. In *Advances in social network analysis*, eds. S. Wasserman and J. Galaskiewicz, pp. 167–203. Thousand Oaks, CA: Sage.
- Rice, R. E. 1999. Artifacts and paradoxes in new media. *New Media & Society* 1(1):24–32.
- Rice, R. E., and Case, D. 1983. Electronic message systems in the university: A description of use and utility. *Journal of Communication* 33(1):131–152.
- Rice, R. E., and Love, G. 1987. Electronic emotion: Socioemotional content in a computer-mediated communication network. *Communication Research* 14(1):85–108.
- Rice, R. E., and Shook, D. E. 1990a. Voice messaging, coordination, and communication. In *Intellectual teamwork: Social and technological foundations of cooperative work*, eds. J. Galegher, R. E. Kraut, and C. Edigo, pp. 327–350. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Rice, R. E., and Shook, D. E. 1990b. Relationships of job categories and organizational levels to use of communication channels, including electronic mail: A meta-analysis and extension. *Journal of Management Studies* 27(2):195–229.
- Rogers, E. M. 1995. *Diffusion of innovations*, 4th ed., New York: Free Press.
- Romm, C. T., and Pliskin, N. 1998. Group development in the virtual workplace: The story of a strike. In *The virtual workplace*, eds. M. Igarria and M. Tan, pp. 368–388. Hershey, PA: Idea Group.
- Salancik, G. R. 1995. Wanted: A good network theory of organization. *Administrative Science Quarterly* 40(2):345–349.
- Short, J., Williams, E., and Christie, B. 1976. *The social psychology of telecommunications*. London: John Wiley & Sons.
- Smith, M. A., and Kollock, P., eds. 1999. *Communities in cyberspace*. London: Routledge.
- Sproull, L., and Kiesler, S. 1986. Reducing social context cues: Electronic mail in organizational computing. *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.
- Steinfeld, C. W., and Fulk, J. 1990. The theory imperative. In *Organizations and communication technology*, eds. J. Fulk and C. W. Steinfield, pp. 13–25. Newbury Park, CA: Sage.
- Sudweeks, F., McLaughlin, M.L., and Rafaeli, S., eds. 1998. *Network and netplay*. Cambridge, MA: MIT Press.
- Trevino, L. K., Daft, R. L., and Lengel, R. H. 1990. Understanding managers' media choice: A symbolic interactionist perspective. In *Organizations and communication technology*, eds. J. Fulk and C.W. Steinfield, pp. 71–94. Newbury Park, CA: Sage.
- Turkle, S. 1995. *Life on the screen: Identity in the age of the internet*. New York: Simon & Schuster.
- van der Poel, M. 1993. *Personal networks: A rational-choice explanation of their size and composition*. Lisse, the Netherlands: Swets & Zeitlinger.
- Walker, J., Wasserman, S., and Wellman, B. 1994. Statistical models for social support networks. In *Advances in social network analysis*, eds. S. Wasserman and J. Galaskiewicz, pp. 53–78. Thousand Oaks, CA: Sage.
- Walther, J. B. 1995. Relational aspects of computer-mediated communication: Experimental observations over time. *Organization Science* 6(2):186–203.
- Walther, J. B., Anderson, J. F., and Park, D. W. 1994. Interpersonal effects of computer-mediated communication: A meta-analysis of social and antisocial communication. *Communication Research* 21(4):460–487.
- Wasserman, S., and Faust, K. 1994. *Social network analysis*. Cambridge, MA: Cambridge University Press.
- Wellman, B. 2001. Computer networks as social networks. *Science* 293(5537):2031–2034.
- Wellman, B., and Berkowitz, S. D., eds. 1998. *Social structures: A network approach*. Cambridge: Cambridge University Press.
- Wellman, B., Carrington, P., and Hall, A. 1988. Networks as personal communities. In *Social structures: A network approach*, eds. B. Wellman and S.D. Berkowitz, pp. 130–184. Cambridge: Cambridge University Press.
- Wellman, B., and Gulia, M. 1999. The network basis of social support: A network is more than the sum of its ties. In *Networks in the global village*, ed. B. Wellman, pp. 83–118. Boulder, CO: Westview Press.
- Wellman, B., and Haythornthwaite, C. Forthcoming. *The Internet in everyday life*. Oxford, UK: Blackwells.
- Wellman, B., Salaff, J., Dimitrova, D., Garton, L., Gulia, M., and Haythornthwaite, C. 1996. Computer networks as social networks:

- Collaborative work, telework, and virtual community. *Annual Review of Sociology* 22:213–238.
- Yates, J., Orlikowski, W. J., and Okamura, K. 1999. Explicit and implicit structuring of genres in electronic communication: Reinforcement and change in social interaction. *Organization Science* 10(1):83–103.
- Yates, J., Orlikowski, W. J., and Rennecker, J. 1997. Collaborative genres for collaboration: Genre systems in digital media. *Proceedings of the 30th Hawaii International Conference on System Sciences*. Los Alamitos, CA: IEEE Computer Society.
- Zuboff, S. 1988. *In the age of the smart machine: The future of work and power*. New York: Basic Books.

Copyright of Information Society is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.