# The Web of Knowledge: An Investigation of Knowledge Exchange in Networks of Practice

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ABSTRACT

Electronic ties are loosening the constraints of organizational structure and physical proximity to allow connectivity between individuals who would otherwise find it difficult to identify and sustain contact with others who share the similar interests.  This paper explores the knowledge exchange processes in extra-organizational networks of practice by studying three technical newsgroups.  We argue that the development of relational social capital is a vital component for transforming electronic posting forums into ongoing networks of practice.  The results reveal that relational social capital exists on networks of practice and shows a strong relationship with knowledge exchange processes over and above the influence of individual motivation and ability.

The concept of a community of practice is emerging as an essential building block of the knowledge economy. Communities of practice are being promoted within organizations as sources of competitive advantage and facilitators of organizational learning (Boland & Tenkasi, 1995; Brown & Duguid, 1998; Davenport & Prusak, 1998; Stewart, 1996). A community of practice is an emergent social collective where individuals working on similar problems self-organize to help each other and share perspectives about their work practice, resulting in learning and innovation within the community (Brown & Duguid, 1991; Wenger, 1998). Communities of practice develop because, in many work situations, the demand of practice exceeds the codified knowledge available to individuals. Knowledge acquired in formal training or through documentation tends to be abstract, theoretical, and decontextualized. On the other hand, situated action cannot be pre-specified, requires improvisation, and is highly contextual. Thus, it becomes necessary to engage in a collective orientation toward practice: joint sensemaking, learning from others' experiences, and accessing distributed know-how.

Individuals increasingly participate in knowledge networks similar to communities of practice, but that cross organizational boundaries, such as the larger professional community to which the organizational member belongs (Venkatraman & Henderson, 1998), and the on-line communities that join suppliers, workers, and customers on the net (Hagel & Armstrong, 1997). Extra-organizational networks focused on practice frequently emerge in fields where the pace of technological change requires access to knowledge and resources that are unavailable within any single organization (Powell, Koput, & Smtih-Doer, 1996). Participants gain access to information and expertise not available locally, and can interact informally free from the constraints of hierarchy and local rules. Engineering and scientific networks that include customers and competitors are an important source of knowledge for technology development

(Allen, 1977; Von Hippel, 1988). Even though the employing organizations may be direct competitors, these informal and reciprocal knowledge exchanges between individuals are valued and sustained over time because the sharing of knowledge is an important aspect of being a member of a technological community (Bouty, 2000). Access to these autonomous, extra-organizational networks is facilitated by the ubiquitous availability of computer networks, and poses novel challenges to organizations attempting to manage their knowledge resources and control their boundaries (Pickering & King, 1995).

The development of online cooperation and knowledge exchange among strangers is one of the prominent developments associated with computer networks (Sproull & Kiesler, 1991; Wallace, 1999). Computer networks are enabling new organizational forms and sustaining cross-organizational knowledge sharing (Alavi & Leidner, 1999; Davenport et al., 1998; Fulk & DeSanctis, 1995). Electronic ties are loosening the constraints of organizational structure and physical proximity to allow connectivity between individuals who would otherwise find it difficult to identify others with similar interests, and to initiate and sustain contact. Because electronic networks support communication between thousands, even tens of thousands of people (Sproull & Faraj, 1995), activities such as giving and receiving technical advice link people who lack previous familiarity, physical proximity, and are unaware of each others' demographic characteristics, organizational setting, or even national culture. However, participation in extra-organizational computer networks benefits organizational members because it provides access to information, expertise, and new ideas across organizational and functional boundaries.

Following Brown and Duguid (1991), we refer to these work-oriented extra-organizational networks as networks of practice. A network of practice is a self-organizing open activity system focused on work practice and that exists primarily through electronic

communication.  A network of practice is similar to a community of practice in that it is a social

space where individuals working on similar problems self-organize to help each other and share

perspectives about their practice.  In a network of practice, people working within occupations,

or having similar interests congregate electronically to engage in knowledge exchange about the

problems and issues that are common to their occupational community and shared practice.

However, there are important differences between a network of practice and a community of

practice.  Due to the reliance on electronic communication, participants in networks of practice

are not limited by a common organizational environment or physical space.  The network is self-

organizing and has no formal sponsor.  Membership is open, most participants do not know each

other, and exchanges are visible to the community as a whole.  The ability to reach everyone in a

network of practice contrasts with the localized tight-knit relationships in a community of

practice.

     While communities of practice within organizations have received increased attention,

much less is known about knowledge exchange in networks of practice that transcend

organizational boundaries.  In spite of the weak ties inherent in such a network, individuals take

the time to provide valuable knowledge and insight in response to a help request posted by a

stranger (Kollock & Smith, 1996; Rheingold, 1993; Wellman et al., 1996). Why members of a

network of practice contribute their time and knowledge to the benefit of strangers when there is

no obvious benefit to do so is not well understood.  In spite of the growing interest in the topics

of virtual organizing and electronic community, surprisingly little empirical research has

investigated the communication and organizing processes in online networks (DeSanctis &

Monge, 1999; Lin, 2001).

This paper explores the knowledge exchange processes in extra-organizational networks of practice by studying three technical newsgroups. We build upon theories of weak ties to suggest that knowledge exchange in these networks is facilitated not only by individual motivation to participate and ability to engage in knowledge exchange, but also by relational social capital. We argue that the development of relational social capital is a vital ingredient in transforming electronic posting forums for dispersed occupational communities into ongoing networks of practice. We present observational data collected over a period of fifty days as well as survey responses from 1,023 people participating in three networks of practice to address three fundamental questions. First, what factors explain why people exchange knowledge in online networks of practice? Second, given the narrow medium of exchange and lack of strong personal ties, does relational capital develop in these networks? And third, to what extent does relational capital enable knowledge exchange in networks of practice over and above individual motivation and ability?

## THEORY AND HYPOTHESES

Network ties and Knowledge Exchange

Prior research in organizations indicates that the sharing of knowledge requires social processes and high bandwidth communication (such as face to face interaction) due to the often tacit nature of knowledge. A certain level of co-presence, social affinity, and socialization is necessary to allow the effective sharing of knowledge that is difficult to codify (Leonard & Sensiper, 1998; Nonaka & Takeuchi, 1995). Studies in face-to-face settings have consistently

found that knowledge sharing is positively related to factors such as: strong ties (Wellman & Wortley, 1990), co-location (Allen, 1977; Kraut, Egido, & Galagher, 1990), demographic similarity (Pelled, 1996), status similarity (Cohen & Zhou, 1991), and a history of prior relationship (Krackhardt, 1992). These studies indicate that strong tie relationships, face-to-face interactions, and dialogue with co-workers within a community of practice are critical for supporting and sustaining knowledge flows.

Characteristics of electronic communication may both hinder and promote the ability to exchange knowledge in networks of practice. In a network of practice, a knowledge seeker that posts a question automatically reaches out to the whole group. In most cases, the message recipients are typically strangers, and their demographic and status cues are not apparent. As a result, the exchange relationship that develops is between an individual and the network as a whole, rather than between individuals. In addition, asynchronous, text-based electronic communication is characterized by low media richness; that is a low ability to provide immediate feedback and the multiple cues necessary for multiplexed communication (Daft, Lengel, & Trevino, 1987; Daft & Lengel, 1986). Specifically, the medium filters out situational cues such as gender, race, nationality, social status, and organizational rank, as well as interactional cues such as body gesture, voice intonation, eye contact, facial expressions, and language variety. However, this lack of cues has been cited as the main reason why computer-mediated groups show more equal participation, less attention to status and demographic differences, and increased participation of peripheral members (Culnan & Markul, 1987; Daft & Hollingshead, 1994; Garton & Wellman, 1995; Keisler & Sproull, 1992).

While individuals may be more inclined to share knowledge with others in their strong tie networks, access to the larger pool of knowledge in a network of practice may prove more

useful, and help overcome the limitations of the technology. Theories of weak ties (Granovetter, 1983; Granovetter, 1973) propose that networks of acquaintances can be viewed as an effective resource for obtaining useful knowledge. The theory suggests that those who access a broad network of weak ties (acquaintances and relative strangers) can gain more useful knowledge compared to individuals relying on their strong ties (friends, family, and close working relations). The key point is that strong ties provide little additional information over what an individual may already know. Thus, weak ties operate as bridges between different densely connected sub-networks. These ties provide access to a larger and possibly more beneficial set of resources and thus serve as effective conduits for new knowledge diffusion and sharing (Burt, 1992; Lin, 2001).

Computer networks have the impact of hardwiring weak ties. They make visible the interactions that in the past may have taken place among individuals or small groups. Messages can be broadcast to all the members of the network with the same ease as sending a message to a single interlocutor. By being on a network, an individual has access to a significantly larger set of potential ties and increased access to valuable resources. However, hardwired weak ties are merely potential ties, since the linkage is based on the physical connectivity made possible by the computer network. It is only when the hardwire tie is used to send a message, does the potential tie become useful. Due to the large, anonymous and open membership of networks of practice, the natural tendency would be to free-ride on the efforts of others by accessing the knowledge available to all members of the community, without replenishing or contributing knowledge to others. Because membership in networks of practice is open, there is minimal social stigma attached to free-riding behavior, for one can draw on group knowledge by "lurking" (i.e. reading without posting) without being noticed by other members. We propose that networks of practice

are able to avoid the tragedy of the commons and sustain valuable knowledge exchange because of member motivation, ability and the development of relational social capital.

Motivation for Knowledge Exchange

In networks of practice, individuals ask questions, request information and know-how, and invest considerable time and effort to provide knowledge and valuable insights to strangers. Since knowledge has a personal and tacit quality, it is difficult to observe its exchange. We view that knowledge exchange has taken place when an individual perceives that they have acquired knowledge from others, or perceives that they have contributed new knowledge to the benefit of others on the network. What motivates people to engage in online knowledge exchange and to sustain the network has remained not well understood. In an empirical study of organizational help seekers on computer networks at a large computer firm, Constant, Sproull, & Kiesler, (1996) found that the most useful sources of technical advice were provided by organizational actors linked only through weak ties on computer networks. Those providing help were driven to share their knowledge due to the motivation of organizational citizenship, and they did not directly know those seeking help. This organizational citizenship explanation, however, does not explain participation in the extra-organizational networks of practice that are the focus of this study, and where participation is open, free, informal, and available to any individual worldwide.

Another explanation views people online as engaged in reciprocal gift exchanges where one provides help without a specific expectation of return, but with the expectation that help will be provided back by others on the network when needed (Fulk, Flanagin, Kalman, Monge, & Ryan, 1996; Kollock, 1999; Rheingold, 1993). Yet, the knowledge seeker has no control over

9

who will respond and whether what they provide is useful. Unlike face-to-face knowledge exchange, the structure of individual gains in networks of practice makes it difficult to provide incentives for individuals to contribute their knowledge to others (Thorn & Connolly, 1987). Further, the issue of the free-rider problem remains: rational individuals can maximize their utility online by simply using the network of practice as a virtual encyclopedia or the equivalent of a staffed help-line.

We identify two possible motivations for individuals to participate in networks of practice: social affiliation and professional affiliation. On one hand, individuals may choose to participate in a network of practice in order to create social relationships and friendships with others who share similar interests. There is early evidence that the Internet is making it possible for people to create and sustain new relationships, thus fulfilling a need for social affiliation and belonging with others (Rheingold, 1993; Walther, 1995; Wellman et al., 1996). By participating in these online forums, individuals get to know people, make new friends, and share emotional support and advice (Galegher, Sproull, & Kiesler, 1998). Thus, participation in knowledge exchange may be based on a pro-social orientation and wanting to meet and build ties with an interesting social circle. As a result, individuals may be motivated to acquire and contribute knowledge out of a personal need for social affiliation and creating friendships. This leads to our first hypotheses:

H1a – Social affiliation will have a positive relationship with knowledge acquisition.

H1b – Social affiliation will have a positive relationship with knowledge contribution.

On the other hand, a key reason individuals engage in both knowledge contribution and knowledge acquisition, may be due to an intrinsic motivation based on professional affiliation, such as self-actualization, learning, staying abreast of new ideas and innovations, and general participation in a professional community. For many knowledge workers, occupational communities are essential social spaces that are at the core of their work and their professional identity. Occupational communities are prevalent among the professions and among skilled workers such as programmers. They provide an environment where knowledge about the state of the practice is shared, reputations established, and social ties renewed (Van Maanen & Barley, 1984). Individuals are more likely to post questions if they are invested and passionate about the knowledge being exchanged. Similarly, potential respondents are more likely to share their knowledge with others when motivated by intrinsic values. Recent work on organizational citizenship behavior (Organ, 1988) and self-concept (Shamir, 1991) indicates the importance of a collective dimension of intrinsic work motivation. Thus, if the self-identity of an expert includes the values and orientation of helping others on complex technical problems, then helping others can lead to increased self-esteem, feelings of commitment, enhanced reputation, and identification with the collective. Therefore, people may be motivated by their intrinsic orientation towards professional affiliation to exchange knowledge in networks of practice. Thus we hypothesize:

H2a – Professional affiliation will have a positive relationship with knowledge acquisition.

H2b – Professional affiliation will have a positive relationship with knowledge contribution.

The Importance of Ability

Even when both parties are motivated, knowledge exchange requires the existence of shared meaning and a common language for discourse. In order to combine and exchange knowledge, learn, and create new knowledge, individuals must be able to understand each other as well as the context in which the knowledge is relevant (Orr, 1996). This reflects the view that knowledge is socially constructed through patterned interactions. In specialized collectives working on narrow issues, the existence of a shared vocabulary and specialized language strengthens within community knowledge sharing and collective identity (Boisot, 1995; Boland et al., 1995). In addition, narratives (such as war stories and little known workarouds) provide contextualized insight into specific situations of how problems were faced and conquered. Those individuals who have mastered the community's specialized language of discourse and are able to comprehend the specialized codes and narratives permeating the group are more likely to participate in knowledge exchange.

We view ability as made up of two related factors: expertise and group tenure. Before an individual can contribute knowledge to others, that individual must possess a certain level of requisite base knowledge (in this case subject expertise) and be familiar with the group's narratives, interactions and special codes. Prior research has found that people with expertise are more likely to provide useful advice (Constant et al., 1996). In addition, people are less likely to contribute when they feel their expertise is inadequate (Wasko & Faraj, 2000), and people are more likely to share knowledge related to their own expertise than other types of knowledge (Constant, Kiesler, & Sproull, 1994). Experts assume specific roles in their communities and act

as sources of knowledge for the network by responding to requests from other members (Stein, 1997).  Therefore, people with low levels of expertise will be more likely to post requests and acquire knowledge from the expert members in the network, and people who are expert members in the network will be more likely to contribute knowledge to others.  This leads to the following hypotheses:

> H3a – High levels of expertise will have a negative relationship with knowledge
> acquisition.
> H3b – High levels of expertise will have a positive relationship with knowledge
> contribution.

Individuals who are long time members of a network of practice are more likely to comprehend the codes and narratives specific to the group, further facilitating their ability engage in knowledge exchange.  Interactions on the network of practice necessitate from a demonstrated familiarity with the local narratives, the specialized vocabulary, and the unique values embedded within the community (Boland et al., 1995; Brown et al., 1991).  Tenure in an organization has been shown to lead to the generation of more useful replies in response to online requests for help (Constant et al., 1996).  Thus, individuals who are long time participants on the network become more familiar with the existing discussion topics, are more up to date on core discussion issues, and are more likely to contribute and acquire new knowledge.  Therefore, we hypothesize that:

H4a – Longer individual tenure in the group will have a positive relationship with

knowledge acquisition.

H4b - Longer individual tenure in the group will have a positive relationship with

knowledge contribution.

So far, we have argued that an individual's motivation and their ability to engage in

knowledge exchange are important factors for explaining knowledge exchange in a network of

practice. However, these factors by themselves do not explain the pro-social behaviors and

attention to managing the commons that such groups exhibit. In the next section, we present

arguments as to the importance of relational social capital for supporting pro-social engagement

and knowledge exchange in networks of practice.

Relational Social Capital and Knowledge Exchange

Social capital has received prominence in recent years as a theory that explains a variety

of pro-social behaviors and linkages, and has seen extensive use in sociology, economics,

education and management. (Bourdieu, 1986; Coleman, 1988; 1990). Much of the interest in

social capital is related to its usefulness in explaining differential social achievements and

actions that other forms of individual-based capital (such as human and financial capital) are

unable to explain. The key difference between social capital and the other forms of capital is that

social capital is embedded in the social realm. While other forms of capital are based on assets

or individuals, social capital resides in the fabric of relations between individuals.

Progress in social capital research has been impeded by broad and tautological definitions, lack of agreement regarding its underlying dimensions, and lack of clarity regarding levels of analysis (Leana & Van Buren, 1999; Lin, 2001; Portes, 1998). Many organization researchers conceptualize social capital at the individual level, and view it as the sum of the resources that an individual can access through social connections. Thus, individuals accrue personal advantage based on their position within a network structure. Specifically, individuals gain advantage when they bridge between tight-knit groups (Burt, 1992; Granovetter, 1973) or are tied to others with superior resources (Lin, 2001). Recent managerial research has favored this private good view of social capital and has demonstrated its explanatory power in areas such as: career success (Seibert, Kraimer, & Liden, 2001), individual reputation (Kilduff & Krackhardt, 1994), success in project-based organizing (DeFillippi & Arthur, 1998), and top management compensation (Barkema & Pennings, 1998). As Burt (2000) succinctly summarized: "better connected people enjoy higher returns."

On the other hand, social capital has also been conceptualized as a group-level attribute that reflects the character of the social relationships within the collective, and is used as a basis to explain collective behavior. From this point of view, social capital is not the sum of individual social networks, but a resource embedded within a social unit and built from pro-social actions (Leana et al., 1999). For example, Coleman (1990) favors a collective good view of social capital and defines it as a relational aspect of a social structure, whose main function is to facilitate actions for those within-structure individuals. Similarly, Bourdieu (1986) regards social capital as an aggregate of the actual or potential resources that are provided to members of a social group by a network of relations. Social capital develops in a social system because closure, shared history, goal interdependence, and frequent interaction nurture a collective

orientation. As a result, individual member access to resources is facilitated due to information connectedness, norms of reciprocity, and expectations of pro-social behavior. Conversely, anti-social behavior is visible, monitored, and eventually sanctioned. This collective good view of social capital has been shown to facilitate extra-organizational knowledge exchange among scientists (Bouty, 2000), new product development team performance (Hansen, Nohria, & Tierney, 1999) and product innovation (Tsai & Ghoshal, 1998). In addition, social capital has been proposed to increase organizational commitment, work flexibility, and innovation (Leana et al., 1999), and as an integrative framework to understand the creation and sharing of knowledge in organizations (Nahapiet & Ghoshal, 1998).

Can collective good social capital develop in networks of practice? Some researchers have suggested that social capital does not develop nor transfer easily to electronic networks (Cohen & Prusak, 2001; Nahapiet et al., 1998; Nohria & Eccles, 1992). The core argument is that social capital requires shared history, high interdependence, frequent interaction and closed structures. Thus, social capital is not expected to extend to an electronic communication medium characterized by low media richness and where participants do not know each other. On the other hand, electronic communication links together people who want to be part of a community of practice, but are only able to, or prefer to interact online. Further, the same low richness medium has been shown to promote personal openness, status-independent participation, and altruistic behaviors (Kiesler & Sproull, 1992; Rheingold, 1993; Wallace, 1999). Lin (2001) argues that social capital is on the rise in worldwide electronic networks due to the ability of the link to support interaction and carry more than just information. Thus, we propose relational social capital as a theoretical framework for explaining why people exchange knowledge, by both contributing knowledge to others and acquiring new knowledge, in networks of practice.

Following Nahapiet and Ghoshal (1998), we examine four primary overlapping constructs composing relational capital: obligation, norms, trust and identification. A varied literature provides support for linking these interrelated constructs to knowledge exchange. Obligations to the collective have been defined as a set of commitments, rights and duties (Bourdieu, 1977). Coleman (1990, p. 310) views the creation of obligations as "a kind of insurance policy for which the premiums are paid in inexpensive currency and the benefit arrives as valuable currency". The key point here is that the relative cost to the helping actor may be low, representing a low cost expenditure (in terms of time, effort, and resources) that creates a future obligation from the needy actor. Later on, when the helping actor needs help, the obligation can be called in at a time when its use has high value. Thus, doing favors is an individually rational economic decision that contributes to the development of collective social capital.

Norms are standards of acceptable conduct that guide and regulate the life of a collective. Coleman (1990) views norms as an essential aspect of social capital. For example, among the community of developers that worked on the technologies underlying the Internet, strong norms developed regarding open access, the respect of intellectual curiosity, merit-based status, and egalitarian interactions (King, Grinter, & Pickering, 1997). As noted by Banks (1997), norms play a vital role in the development of self-help groups because they embed new members in a social tissue that increases the value of the collective good, and norms counter impulses to behave selfishly (Banks, 1997). Thus, norms are important in that they allow communities to function effectively and to produce a collective good.

Trust has been identified by several authors as a key enabler for interpersonal exchange and cooperation in organizations (McAllister, 1995; Ring & Van de Ven, 1994; Shapiro, 1987;

Smith et al., 1994; Tsai et al., 1998). The existence of trust in organizational work-relations

leads to the development of supportive roles, communal relationships, high confidence in others,

free exchange of knowledge, and help-seeking behaviors (Jones & George, 1998). A recent

empirical study found that trust leads to increased openness and more effective knowledge

transfer between partner representatives of organizations engaged in cooperative relationships

(Wathne, Roos, & Krough, 1996). Trust is especially important in on-line environments, since

social and interactional cues are filtered out.

Identification reflects the fit between an individual's identity and that of the larger

collective. A high level of identification with the salient group can lead to knowledge outcomes.

Specifically, identification allows a party to understand, appreciate, and feel invested in what

others want and need. Identification enhances "the frequency of cooperation and provides a far

better explanation than self-interest approaches for understanding cooperative behavior"

(Lewicki & Bunker, 1996). People who identify strongly with the network are more likely to

help others, and seek help when needed due to their sense of affiliation with the network.

All four constructs can be viewed as reflecting the cooperative environment and the

development of a sharing context. Together, these relational constructs reflect the existence of

shared values and positive affective orientation, which have been found to promote social

interaction and creativity (Isen & Baron, 1991). As noted by Boisot (1995), a shared context is

the prime vehicle for the transmission of knowledge. An environment which is low on these

relational dimensions of social capital becomes an obstacle to cooperation and knowledge

sharing. We suggest that people who feel obligated to participate in the network of practice,

understand the norms underlying exchange in the network, trust other members of the network,

and identify with the network, are more likely to engage in knowledge exchange over and above

18

individual motivation and ability.  Figure 1 provides a summary of our theoretical model. This

argument leads to our final hypotheses:

H5a  Relational capital, in the form of obligation, norms, trust, and identification will be

positively related to knowledge acquisition over and above individual willingness and ability.

H5b  Relational capital, in the form of obligation, norms, trust, and identification will be

positively related to knowledge contribution over and above individual willingness and ability.

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Figure 1 about here
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## METHOD

Sample and Procedures

For the purpose of this study, we selected three technical computer-related newsgroups

on the Usenet.  The Usenet is a key element of the Internet that was created in 1981 and has

grown to include over twenty-five thousand different interest newsgroups with more than half a

million postings per day (Dern, 1999).  Newsgroups are self-organizing, electronic forums where

issues associated with the topic of the newsgroup are discussed.  Contrary to face-to-face groups,

newsgroups are open to anyone interested in participating and have no limit on group size.

Participation in the group is voluntary and occurs when a message is posted, becoming visible to

all those who read the newsgroup.  Little information about participants is available except for

the email address and what the poster voluntarily chooses to disclose (see Kollock et al., 1995; Sproull et al., 1996 for more detailed information).

This study combines participation data, taken from the actual newsgroup postings, with survey responses from newsgroup participants. We saved and examined all of the messages posted to: comp.lang.c++, comp.databases, and comp.object for a period of 50 days. A description of group characteristics is provided in appendix A. We chose these three groups out of the available technical groups due to their focus on technical knowledge sharing significant to organizations, and because of the market value and relevance that is placed on expertise in these areas. The seven-week time frame was deemed necessary to control for daily or weekly peaks in group participation, while maintaining the data set size at a manageable level. We analyzed the 14,196 saved messages and generated an e-mail list consisting of every unique person that had posted to the groups.

We identified a total of 4,879 unique participants and sent them an electronic survey. Five hundred and nineteen surveys were returned due to an invalid address. We received a total of 1,023 usable survey responses from the 4,360 participants that had valid email addresses (response rate of 24%). As a check for non-response or for skewed-response bias in our sample, we compared posting activities between people who had responded to our survey and those of non-respondents. We compared only the people who posted more than two messages during the seven-week period in order to control for random "noise" postings (such as job announcements, cross-posts, and spam posts). The participation rate of people who responded to the survey was not significantly different from that of non-respondents ($F = .516$, *n.s.*).

Measures

20

Perceived knowledge exchange. We assessed two dimensions to measure perceived knowledge exchange, the dependent measure in this study: perceived knowledge acquisition and perceived knowledge contribution. Both measures were adapted from Wathne, Roos and von Krogh (1996), and group members were asked to rate four statements, on a 7 point scale (very small extent; very great extent) starting with "From your participation in this newsgroup, have you..".

Perceived knowledge contribution. Without people willing to contribute their valuable, personal knowledge to others, combination and exchange would not occur. The extent to which group members contribute new knowledge was estimated by asking respondents to rate the extent of agreement with two statements: have you contributed new knowledge to this newsgroup, and have you contributed knowledge to other members that resulted in their development of new insights.

Perceived knowledge acquisition. This measure estimates the level of knowledge acquired from group participation (i.e. learning) that has occurred. We estimated the degree to which members acquired knowledge by asking: have you acquired knowledge that caused you to develop new insights, and have you acquired knowledge that enabled you to perform new tasks.

Individual motivation. We measured two individual motivation factors: social affiliation, and professional affiliation. The motivations for participation were assessed by asking group members how strongly they disagreed/agreed on a seven point scale to statements beginning with "one of my reasons for participation is..".

21

Social affiliation. One reason why people participate in Newsgroups is to develop personal friendships and create social ties with people sharing similar interests. We used four survey questions (to build friendships with others, to meet new and different people, to be socially competent and skillful, and to gain a feeling of belonging) to assess social affiliation. These measures were adapted from Beard and Ragheb (1983).

Professional affiliation. Another reason why people may be motivated is for self-actualization and to support their professional identity. Thus, they may participate in order to have access to fellow experts with specialized skills and knowledge. The professional affiliation motivation underlying why people participate in the group was assessed from three survey questions (to exchange advice and solutions with knowledgeable members of the group, to help other group members with their problems, and to keep abreast of new ideas and innovations). These measures were adapted from Thomsen (1996).

Ability. In addition to an individual's motivation to participate, people must also have the ability to engage in exchange. We use two measures to assess an individual's ability to engage in knowledge exchange: subject expertise and tenure in the group.

Subject expertise. Without subject matter expertise, members would have nothing to contribute to the group. The level of a respondent's expertise in the topic area of the newsgroup reflects the existence of a common set of shared language and codes. We assessed individual subject expertise by asking respondents to self-rate, on a 7 point scale, their level of subject matter expertise (how would you rate your expertise on the subject matter of this group? Scale: Novice - Expert).

Tenure.  Tenure in the group is a measure of how long an individual has participated in the group.  The longer the respondent has belonged to the group, the higher their level of understanding of the shared language of the group, narratives, and codes.  We assessed group tenure, in months, by asking respondents "How long have you been a member of this group, in months."  This variable was transformed to correct for moderate skewness.

Relational social capital.  We used four variables to estimate relational social capital: obligations, norms, trust and identification.  These dimensions were identified by Nahapiet and Ghoshal (1998) as making up relational social capital.  All relational social capital measures were determined by asking respondents to rate, on a 7 point scale, the extent of their agreement (to a very small extent - a very great extent) with different statements.

Obligation.  Obligation is a measure of the extent of commitment an individual has to the group, and is critical for sustaining group dynamics over time.  How obligated group members were to the group was estimated through the extent of agreement with three statements: do you feel responsible to help group members, do you feel a sense of obligation to participate, and do you feel that other group members expect you to participate.

Norms.  Norms are the sets of rules, or standard procedures that are used to constrain behavior, and can be either explicit and clearly stated, or implicit and emerge through group dynamics.  Group norms were measured through survey questions asking respondents to indicate their agreement with three statements: are you aware of this newsgroup's set of norms or rules for participation, are you aware of this newsgroup's guidelines about appropriate interaction, and does this newsgroup have norms and expectations about what constitutes appropriate interaction.

Trust.  Members are more likely to share their personal knowledge with people that they trust.  Therefore trust should have a critical role in predicting knowledge exchange.  The extent to which group members place trust in the group was estimated by asking respondents to rate their agreement with three statements.  These measures were adapted from McAllister (1995): active group members are trustworthy in terms of the accuracy of the knowledge and information they provide, I trust the quality of the information and knowledge provided by active group members, and if I share my technical problems with the group, I know active group members will respond constructively and caringly.

Identification.  Identification is a measure of the overlap between a respondent's personal identity, and the social identity of a collective.  To assess how strongly members identify with the newsgroup, respondents were asked to rate the extent to which they agree with two statements: would you feel a loss if you were no longer able to participate in the newsgroup, and how strongly do you identify with this newsgroup.


Control Variables.  We controlled for two factors in this study: group and participation.  Because knowledge exchange may be affected by the specific dynamics of a group, we created two dummy variables *group1* and *group2* to allow us to model which of the three newsgroups the respondent is in.  We also controlled for participation.  In networks of practice, individuals who participate often are more likely to perceive that they are invested in the network's primary purpose and likely to rate themselves as more active in knowledge exchange (both knowledge contribution and knowledge acquisition) compared to those who post less frequently.  Participation was measured by counting the number of messages posted by each respondent over

the seven weeks study's period. Because a majority of respondents posted only a few times, resulting in a skewed distribution, we used a logarithmic transformation for participation.

Analysis Approach

We used hierarchical regression analysis to test the theoretical model. We ran two sets of hierarchical regressions, one for knowledge acquisition and one for knowledge contribution. Hierarchical regression analysis makes it possible to test whether a set of variables, entered as a block and in a theoretically justified order, adds significantly to variance already explained by a prior set of variables. In the first step, we entered the two dummy variables (representing group differences) and participation. In the second step, we entered the two motivation variables and the two ability measures. In the third step, we entered the four terms that make up relational social capital. Motivation and ability measures were entered first into the model because in networks of practice, these individual factors may be sufficient for the combination and exchange of knowledge. Relational social capital is entered into the model last to test its effects on knowledge exchange over and above motivations and ability.

RESULTS

Convergent and Discriminant Validity

Convergent validity is concerned with the amount of agreement among the multiple items making up a construct. Table 1 presents the Cronbach alphas for our variables. The average

Cronbach alpha was .79 with only a single motivation variable at .62 and thus marginally lower than the generally accepted .7 level.

Discriminant validity is useful to demonstrate the extent to which a construct of interest differs from others. We used a principal component factor analysis to test that the various items load up highest on their theoretical constructs. We ran one factor analysis containing all multi-item constructs (2 motivation constructs, 4 relational capital constructs, knowledge contribution and knowledge acquisition). The results indicate the existence of two separate dimensions of motivation (all items loaded on their expected factors at a level of .69 or higher), four separate dimensions of relational capital (all items loaded on their expected factors at a level of .69 or higher), and two clearly separate dimensions of knowledge exchange (all items loaded on their expected factors at a level of .84 or higher). Actual results of factor analysis are presented in Appendix B. Table 1 presents the inter-construct correlations.

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Table 1 about here
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Assessment of Common Method Bias

We used several procedures to control and test for common method bias. First, we designed the survey to use a combination of "concrete" measures (e.g., how long have you been a member in this Newsgroup in months), and then varied the wording and stems for the "less concrete" constructs. Such a procedure reduces the cognitive complexity of the judgment that a rater must make to answer a scale item, and thus is recommended in order to reduce common

26

method bias (Doty & Glick, 1998).

Second, following Podsakoff and Organ (1986) and Scott and Bruce (1994), we performed a principal component factor analysis on all of the multi-item constructs (6 independent and 2 dependent measures) in order to empirically test for common method variance. The results of the factor analysis indicated the existence of 8 factors corresponding to our constructs and accounting for 73.4 percent of the total variance. The largest factor accounted for only 24.3 percent (as opposed to the majority) of the variance and was made up of its theoretically pre-specified measures. The average item loading on its intended construct was .81, and crossloadings were less than .29. These results suggest that the relationship between the independent and criterion variables was not hampered by excessive common method variance and thus represents no major threat to our analysis.

Third, we performed an additional analysis to examine actual message posting activity and its relation to survey measures. In order to support the validity of the knowledge contribution variable, we randomly selected 200 respondents and reviewed their message postings. The messages were coded as either requests for help, or responses to requests from others. We then created an aggregate score for each individual to determine what percentage of his/her activity was requesting/responding. We found a strong correlation between individuals who mainly post response messages and perceptions of knowledge contribution (corr. = .347, p<.001), thus supporting the validity of our perceptual measures of knowledge exchange.

Hypotheses Testing - Knowledge Acquisition

Table 2 presents the results of the hierarchical regression analysis for knowledge acquisition. Model 1 examines the impacts of group differences and participation. The model is significant ($F = 7.04$, $p < .001$). Model 2 presents the regression results associated with the individual motivation and ability factors (social affiliation, professional affiliation, expertise and tenure in the group). The $R^2_{adj}$ of the model is 15%, and is statistically significant ($?R^2 = .13$, $F$ for $?R^2 = 28.53$, $p < .001$). Thus, individual motivations and ability are associated with knowledge acquisition. Model 3 assesses the additional impact of relational capital over and above the other factors. The model is significant ($R^2_{adj} = .32$, $?R^2 = .17$, $F$ for $?R^2 = 47.76$, $p < .001$), and provides support for hypothesis 5a that relational social capital explains knowledge acquisition over and above the other factors.

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Table 2 about here
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In addition to assessing the impact of variables entered as a block, regression analysis allows the evaluation of the contribution of each variable. In the full model (Model 3), we note that group differences are no longer significant in the presence of the other variables. Similarly, the frequency of participation in the group did not have a significant impact on knowledge acquisition. On the other hand, social affiliation has a significant negative relationship with knowledge acquisition ($b = -.07$, $p < .05$), contrary to hypothesis 1a that hypothesized a positive relationship. As predicted in hypothesis 2a, professional affiliation motivation is a significant predictor of knowledge acquisition ($b = .16$, $p < .001$). Among the ability factors, subject expertise was significant, but negative ($b = -.10$, $p < .01$) providing support for hypothesis 3a,

and individual tenure was significant ($b = .07, p < .05$), as predicted by hypothesis 4a. Finally, the relational capital variables: norms ($b = .08, p < .01$), trust ($b = .19, p < .001$) and identification ($b = .35, p < .001$) were all positive and significant. However, obligation did not have a significant relationship with knowledge acquisition.

Hypotheses Testing - Knowledge Contribution

Table 3 presents the results of the hierarchical regression analysis for knowledge contribution. Model 1 (differences between groups and participation) was significant ($F = 22.97, p < .001$). Model 2 presents the regression results associated with individual motivation and ability factors, and was significant ($R^2_{adj} = 33\%$, $?R^2 = .24$, $F$ for $?R^2 = 67.52, p < .001$). Model 3 assesses the additional impact of relational capital over and above the other factors. The model is significant ($R^2_{adj} = 37\%$, $?R^2 = .05$, $F$ for $?R^2 = 15.44, p < .001$), and provides support for hypothesis 5b that relational social capital explains knowledge contribution over and above the other factors.

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Table 3 about here
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In the full model (Model 3), the groups differed significantly in terms of knowledge contribution ($b = -.10, p < .05$; $b = -.13, p < .01$). Respondents in comp.object and comp.lang.c++ perceived that they contributed less knowledge than respondents in comp.databases. Participation ($b = .15, p < .001$) was a significant predictor of knowledge contribution. As in the results for knowledge acquisition, professional affiliation motivation is positive and significant ($b = .07, p < .05$), supporting hypothesis 2b. Social affiliation was not a

29

significant predictor of knowledge contribution counter to predictions in hypothesis 1b. Both ability variables, subject expertise ($b = .34$, $p < .001$) and tenure in the group ($b = .09$, $p < .05$) had significant, positive relationships with knowledge contribution, providing support for hypothesis 3b, and hypothesis 4b. Finally, the relational capital variables: obligation ($b = .16$, $p < .001$), norms ($b = .08$, $p < .05$), and identification ($b = .13$, $p < .001$) were all positive and significant. However, trust did not have a significant relationship with knowledge contribution.

## DISCUSSION

Although there is increased interest and focused attention on the importance of knowledge exchange and new knowledge creation, to date there has been little research on the dynamics of knowledge exchange via computer networks. This study's primary goal was to develop and test a model explaining knowledge exchange in computer-mediated networks of practice. Our findings provide some evidence that several essential aspects of communities of practice, including the development of social relations and shared activities around a common practice, operate in open electronic forums. In spite of the lean communication medium, lack of co-location and organizational sponsorship, networks of practice are supporting knowledge exchange between members. Recently, researchers noted the emergence of online networks of practice and speculated whether they shared similar knowledge exchange processes with the richer face-to-face communities of practice (Brown & Duguid, 2000; Cohen et al., 2001). As such, our study provides positive evidence that there are important similarities, and this study is one of the first to develop and test a full model in order to examine on-line dynamics and explain what sustains knowledge exchange between members.

This study increases our understanding of the relative importance of each of individual motivations, abilities, and relational social capital for predicting knowledge exchange in networks of practice. The motivation for professional affiliation had a positive and significant relationship with both knowledge acquisition and knowledge contribution, confirming the importance of intrinsic motivation to engage in knowledge exchange with like-minded others in electronic networks. On the other hand, people who participate due to a social affiliation motivation were not associated with contributing knowledge, and were significantly less likely to acquire knowledge from their participation in the network. These results support the argument put forth within the communities of practice literature that knowledge workers participate in such communities not to satisfy a need for socializing, but rather because their self-identity requires engagement in the ongoing process of working, learning, and innovating (Brown et al., 1991; Orr, 1996; Wenger, 1998). In addition, this study provides evidence that people participate in networks of practice due to an affiliation with the profession as a whole, thus networks of practice differ from communities of practice in that they provide a forum for the sharing of ideas across the professional and/or occupational community as whole, regardless of organizational boundaries. These findings suggest the need for additional research that examines the influence of occupational communities on internal organizational practices (Van Maanen et al., 1984).

Our results also suggest that ability links to knowledge exchange. Subject expertise was negatively related to knowledge acquisition, implying that novices learn more than experts from participation in the network. However, people who have been members of the network longer were more likely to acquire knowledge. In addition, subject expertise was positively related to knowledge contribution, implying that experts tend to actively share their knowledge. Thus, experts play a vital role in networks of practice by contributing knowledge to the benefit of

31

others, and sustaining the dynamics of exchange in the network. These findings confirm and extend previous research on the importance of understanding a shared language of discourse and long time embeddedness in the referent community to support knowledge exchange (Boland et al., 1995).

The empirical results also suggest that relational social capital plays a crucial role in explaining knowledge exchange processes in electronic networks of practice over and above individual motivation and ability. Our study provides empirical support for the multi-dimensional conceptualization of relational social capital introduced by Nahapiet and Ghoshal (1998), and validates measures for those dimensions. Our results confirm that relational social capital is a powerful resource contributing to knowledge exchange, and for the first time, confirm its existence in non-face-to-face, unbounded groups that rely on electronic communication. The role of relational social capital appears to serve as a foundation for why hardwired, weak ties become useful, even in a low-richness asynchronous communication medium. We found that two dimensions of relational capital, norms and identification were significant predictors of both knowledge contribution and knowledge acquisition, over and above motivation and ability. Thus, understanding the norms of exchange and feeling a sense of identification with the network supports substantive involvement and knowledge exchange. This implies that both knowledge seekers and knowledge providers are relationally embedded in the network and may be less prone to free-riding and knowledge hoarding behaviors.

However, contrary to the model proposed by Nahapiet and Ghoshal (1998), the other two dimensions of relational social capital, trust and obligation, seem to support knowledge exchange in different ways. Obligation, and not trust, was a significant predictor for knowledge contribution. This indicates that people are willing to share their personal knowledge due to a

sense of obligation to the network, without necessarily trusting other members in the network. On the other hand, individuals that acquired knowledge from the network seem to trust in other members and the knowledge they provide. However, those same individuals feel little obligation to contribute to others. One possible explanation may be that knowledge acquirers are not knowledgeable enough to assess the validity of the answers received and thus choose to trust the knowledge received and the goodwill of the provider. A related explanation is that most knowledge seekers use the network in a utilitarian way as a free resource (akin a private "help desk") and are not interested in contributing themselves.

Trust, in the form of beliefs about the appropriateness of someone's action, has recently been promoted as an important enabler of: cooperative relationships (e.g.Jones et al., 1998; Kramer & Tyler, 1996), effective knowledge management (Davenport et al., 1998) and online cooperation (Jarvenpaa & Leidner, 1999). Our findings suggest certain limitations on the importance of trust for electronic knowledge exchange. A likely explanation is that the knowledge contributors generally possess a high degree of subject expertise, and thus are better able to assess the quality of the knowledge exchanged on the network. For an expert, much of the knowledge that is posted on the network may appear to be badly formulated, of dubious value, or sometimes even untrue. Thus, trust, as a previously defined in the literature may be too broad a concept to be useful for understanding online cooperative behaviors and knowledge exchange. Our results suggest that trust must be clearly contextualized to the environment and made contingent to the task. Based on the complex interrelations that we found, future research on online cooperation may benefit from viewing trust as one dimension of the broader concept of relational capital.

These specific findings suggest that knowledge contribution is sustained in networks of practice by a core group of active members who generally are high in expertise and have participated over a long period of time. These members feel obligated to help sustain the network as a community of learning and shared practice. They exhibit high levels of the relational social capital dimensions of obligation, identification, and norms, but do not easily trust the contributions of others. When contrasted with knowledge seekers, it becomes apparent that the network of practice is not a random amalgamation of people with varying ability, motivation, and relational social capital. Rather, the network seems to be divided between a core of expert knowledge providers and a periphery of less involved knowledge seekers. This finding supports the community of practice research that emphasizes legitimate peripheral participation as a key aspect of learning and knowledge transfer (Lave, 1991; Wenger, 1998). Future research on networks of practice may need to highlight the impact of individual's position within the core-periphery in order to better understand behaviors and beliefs.

A number of limitations in this study should be recognized. First, the study relied on cross-sectional data collection. On one hand, this methodology is appropriate for model testing, and our large sample size provides robust findings regarding specific relationships between variables. On the other hand, a cross-sectional approach tells us little about how relational social capital develops over time and what factors influence its development. Second, the use of subjective rather than objective measures of knowledge exchange is a potential limitation. While our confidence in the results is high due to the incorporation of both survey measures as well as observational measures, future researchers may want to collect more objective measures of knowledge exchange. Third, generalizability of the study findings is an issue. How representative are our findings for other networks of practice? We focused on three well-known

and high traffic technical networks on the Usenet, and are reasonably confident that they are representative of the open membership groups of the Internet. However, networks of practice within organizations, as well as other forms of electronic groups may have different membership and exchange dynamics. Other studies using the same constructs but in other contexts (intranets, distribution lists, organizational groups, a more diverse set of Usenet groups) are necessary before dispelling the generalizability threat.

In sum, networks of practice arising from the ubiquity of computer networks are enabling direct communication and knowledge exchange across functional, organizational and national boundaries. We found that in spite of the limitations of the medium and the prevalence of weak tie relationships, relational social capital is an essential component underlying knowledge exchange over and above individual motivations and abilities. Our findings also suggest different theoretical frameworks may be needed to understand the actions of individuals who contribute knowledge and those who acquire knowledge through participation in the network. As researchers continue to study knowledge exchange, both inside and outside organizations, a social capital perspective may be an important lens to examine how electronic networks become webs of knowledge.

## REFERENCES

Alavi, M. & Leidner, D. 1999. Knowledge management systems: Issues, challenges and benefits. Communication of the Association for Information Systems, 1: 1-28.

Allen, T. J. 1977. Managing the Flow of Technology. Cambridge, MA: MIT Press.

Banks, E. 1997. The social capital of self-help mutual aid groups. Social Policy, Fall: 30-38.

Barkema, H. G. & Pennings, J. M. 1998. Top management pay: Impact of overt and covert power. Organization Studies, 19(6): 975-1003.

Beard, J. & Ragheb, M. 1983. Measuring Leisure Motivation. Journal of Leisure Research, 15(3): 219-228.

Boisot, M. H. 1995. Information Space. London: Routledge.

Boland, R. J., Jr & Tenkasi, R. V. 1995. Perspective making and perspective taking in communities of knowing. Organization Science, 6(4): 350-372.

Bourdieu, P. 1977. Outline of a theory of practice. New York: Cambridge University Press.

Bourdieu, P. 1986. The forms of capital. In J. G. Richardson (Ed.), Handbook of Theory and Research for the Sociology of Education. New York: Greenwood.

Bouty, I. 2000. Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries. Academy of Management Journal, 43(1): 50-66.

Brown, J. S. & Duguid, P. 1991. Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. Organization Science, 2(1): 40-57.

Brown, J. S. & Duguid, P. 1998. Organizing knowledge. California Management Review, 40(3): 90-111.

Brown, J. S. & Duguid, P. 2000. Balancing act: How to capture knowledge without killing it. Harvard Business Review, May-June: 73-80.

Burt, R. 2000. The network structure of social capital. In R. I. Sutton & B. M. Staw (Eds.), Research in Organizational Behavior. Greenwich, CT: JAI Press.

Burt, R. S. 1992. Structural Holes: The Social Structure of Competition. Cambridge, MA: Harvard University Press.

Cohen, B. P. & Zhou, X. 1991. Status processes in enduring work groups. American Sociological Review, 56(179-188).

Cohen, D. & Prusak, L. 2001. In Good Company: How Social Capital Makes Organizations Work. Boston, MA: Harvard Business School Press.

Coleman, J. S. 1988. Social capital in the creation of human capital. American Journal of Sociology, 94: S95-S120.

Coleman, J. S. 1990. Foundations of Social Theory. Cambridge, MA: Belknap Press of Harvard University Press.

Constant, D., Kiesler, S., & Sproull, L. 1994. What's mine is ours, or is it? A study of attitudes about information sharing. Information Systems Research, 5(4): 400-422.

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

Culnan, M. J. & Markul, M. L. 1987. Information Technologies. In F. M. Jablin & L. L. Putnam & K. H. Roberts & L. W. Porter (Eds.), Handbook of Organizational Communication: An Interdisciplinary Perspective: 421-443. Newbury Park, CA: Sage.

Daft, J. E., Lengel, R. H., & Trevino, L. K. 1987. Message equivocality, media selection, and manager performance: Implication for information systems. MIS Quarterly, 11: 354-366.

Daft, J. E. & Hollingshead, A. B. 1994. Groups Interacting with Technology. Thousand Oaks, CA: Sage Publications.

Daft, R. L. & Lengel, R. H. 1986. Organizational information requirements, media richness and structural design. Management Science, 32(5): 355-366.

Davenport, T. H. & Prusak, L. 1998. Working Knowledge. Boston: Harvard Business School Press.

DeFillippi, R. J. & Arthur, M. B. 1998. Paradox in project-based enterprise: The case of film making. California Management Review, 40(2): 125-139.

Dern, D. 1999. Usenet -- Still useful after all these years, BYTE, Vol. April, 5.

DeSanctis, G. & Monge, P. 1999. Communication processes for virtual organizations. Organization Science, 10(6): 693-703.

Doty, D. H. & Glick, W. H. 1998. Common methods bias: does common methods variance really bias results. Organizational Research Methods, 1(4): 374-406.

Fulk, J. & DeSanctis, G. 1995. Electronic communication and changing organizational forms. Organization Science, 6(4): 337-350.

Fulk, J., Flanagin, A. J., Kalman, M. E., Monge, P. R., & Ryan, T. 1996. Connective and communal public goods in interactive communication systems. Communication Theory, 6(1): 60-87.

Galegher, J., Sproull, L., & Kiesler, S. 1998. Legitimacy, authority, and community in electronic support groups. Written Communication, 15(4): 493-530.

Garton, L. & Wellman, B. 1995. Social impacts of electronic mail on organizations: A review of the research literature. Communication Yearbook, 18: 434-453.

Granovetter, M. 1983. The strength of weak ties: A network theory revisisted. Sociological Theory, 1: 201-233.

Granovetter, M. S. 1973. The strength of weak ties. American Journal of Sociology, 91: 481-510.

Hagel, J. & Armstrong, A. G. 1997. Net.gain: Expanding Markets through Virtual Communities. Boston, MA: Harvard Business School Press.

Hansen, M. T., Nohria, N., & Tierney, T. 1999. What's your strategy for managing knowledge. Harvard Business Review, 77(2): 106-116.

Isen, A. M. & Baron, R. A. 1991. Positive affect as a factor in organizational behavior. In B. M. Staw & L. L. Cummings (Eds.), Research in Organizational Behavior, Vol. 13. Greenwich, CO: JAI Press.

Jarvenpaa, S. L. & Leidner, D. E. 1999. Communication and trust in global virtual teams. Organization Science, 10(6): 791-815.

Jones, G. R. & George, J. 1998. The experience and evolution of trust: Implications for cooperation and teamwork. Academy of Management Review, 23(3): 531-546.

Keisler, S. & Sproull, L. 1992. Group decision making and communication technology. Organizational Behavior and Human Decision Processes, 52: 96-123.

Kiesler, S. & Sproull, L. 1992. Group decision making and communication technology. Organizational Behavior and Human Decision Processes, 52: 96-123.

Kilduff, M. & Krackhardt, D. 1994. Bringing the individual back in: A structural analysis of the internal market for reputation in organizations. Academy of Management Journal, 37(1): 87-95.

King, J. L., Grinter, R. E., & Pickering, J. M. 1997. The rise and fall of netville: The saga of a cyberspace construction boomtown in the great divide. In S. Kielser (Ed.), Culture of the Internet. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kollock, P. & Smith, M. A. 1996. Managing the virtual commons: Cooperation and conflict in computer communities. In S. Herring (Ed.), Computer-Mediated Communication: Linguistic, Social and Cross Cultural Perspectives: 109-128. Amsterdam: John Benjamins.

Kollock, P. 1999. The economies of online cooperation: Gifts, and public goods in cyberspace. In M. A. Smith & P. Kollock (Eds.), Communities in Cyberspace: 220-239. London: Routledge.

Krackhardt, D. 1992. The strength of strong ties: The importance of philos in organizations. In N. Nohria & R. Eccles (Eds.), Organizations and networks: Structure, form, and action: 216-239. Boston: Harvard Business School Press.

Kramer, R. M. & Tyler, T. R. 1996. Trust in Organizations. Thousand Oaks, CA: Sage Publications.

Kraut, R. E., Egido, C., & Galagher, J. 1990. Patterns of contact and communication in scientific research collaboration. In J. Galagher & R. E. Kraut & C. Egido (Eds.), Intellectual Teamwork. Hillsdale, NJ: Lawrence Erlbaum Associates.

Lave, J. 1991. Situating learning in communities of practice. In L. B. Resnick & J. M. Levine & S. D. Teasley (Eds.), Perspectives on Socially Shared Cognition: 63-82. Washington, D.C.: American Psychological Association.

Leana, C. R. & Van Buren, H. J. I. 1999. Organizational social capital and employment practices. The Academy Management Review, 24(3): 538-555.

Leonard, D. & Sensiper, S. 1998. The role of tacit knowledge in group innovation. California Management Review, 40(3): 112-132.

Lewicki, R. J. & Bunker, B. B. 1996. Developing and maintaining trust in work relationships. In R. M. Kramer & T. R. Tyloer (Eds.), Trust in Organizations. London: Sage Publications.

Lin, N. 2001. Social Capital. Cambridge UK: Cambridge University Press.

McAllister, D. 1995. Affect- and cognition-based trust as foundations for interpersonal cooperation in organizations. Academy of Management Journal, 38(1): 24-59.

Nahapiet, J. & Ghoshal, S. 1998. Social capital, intellectual capital, and the organizational advantage. Academy of Management Review, 23(2): 242-266.

Nohria, N. & Eccles, R. G. 1992. Face-to-face: Making network organizations work. In N. Nohria & R. G. Eccles (Eds.), Networks and Organizations: Structure, Form and Action: 288-308. Boston: Harvard Business School Press.

Nonaka, I. & Takeuchi, H. 1995. The Knowledge-creating Company. Oxford: Oxford University Press.

Organ, D. E. 1988. Organizational Citizenship Behavior. Lexington, MA: Lexington Publishers.

Orr, J. 1996. Talking About Machines: An Ethnography of a Modern Job. Ithaca, NY: ILR Press.

Pelled, L. H. 1996. Demographic diversity, conflict, and work group outcomes: An intervening process theory. Organization Science, 7: 615-631.

Pickering, J. M. & King, J. L. 1995. Hardwiring weak ties: Interorganizational computer-mediated communication, occupational communities, and organizational change. Organization Science, 6: 479-486.

Podsakoff, P. & Organ, D. 1986. Self reports in organizational research: problems and prospects. Journal of Management, 12: 531-544.

Portes, A. 1998. Social capital: its origins and applications in modern sociology. Annual Review of Sociology, 24: 1-24.

Powell, W. W., Koput, K., & Smtih-Doer, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. Administrative Science Quarterly, 41: 116-145.

Rheingold, H. 1993. The Virtual Community: Homesteading on the Electronic Frontier. Reading, MA: Addison Wesley.

Ring, P. S. & Van de Ven, A. H. 1994. Developmental processes of cooperative interorganizational relationships. Academy of Management Review, 19: 90-118.

Scott, S. G. & Bruce, R. A. 1994. Determinants of innovative behavior: A path model of individual motivation in the workplace. Academy of Management Journal, 37(3): 580-607.

Seibert, S. E., Kraimer, M. L., & Liden, R. C. 2001. A social capital theory of career success. Academy of Management Journal, 37(3): 580-607.

Shamir, B. 1991. Meaning, self and motivation in organizations. Organization Studies, 12: 405-424.

Shapiro, S. P. 1987. The social control of impersonal trust. American Journal of Sociology, 93: 623-658.

Smith, K. G., Smith, K. A., Olian, J. D., Sims, H. P., O'Bannon, D. P., & Scully, J. A. 1994. Top mangement team demography and process: The role of social integration and communication. Administrative Science Quarterly, 39: 412-438.

Sproull, L. & Faraj, S. 1995. Atheism, sex and databases: The net as a social technology. In B. K. J. Keller (Ed.), Public Access to the Internet: 62-81. Cambridge, MA: MIT Press.

Sproull, L. S. & Kiesler, S. 1991. Connections. Cambridge, MA: MIT Press.

Stein, E. W. 1997. A look at expertise from a social perspective. In P. J. Feltovich & K. M. Ford & R. R. Hoffman (Eds.), Expertise in Context: 181-194. Menlo Park, CA: AAAI Press.

Stewart, T. A. 1996. The invisible key to success. Fortune, August 5.

Thomsen, S. 1996. "@ Work in cyberspace": Exploring practitioner use of the PRForum. Public Relations Review, 22(2): 115-131.

Thorn, B. K. & Connolly, T. 1987. Discretionary data bases. A theory and some experimental findings. Communication Research, 14(5): 512-528.

Tsai, W. & Ghoshal, S. 1998. Social capital and value creation: The role of intrafirm networks. Academy of Management Journal, 41: 464-478.

Van Maanen, J. & Barley, S. R. 1984. Occupational communities: Culture and control in organizations. In B. M. Staw & L. L. Cummings (Eds.), Research in Organizational Behavior, Vol. 6. Greenwich, CO: JAI Press.

Venkatraman, N. & Henderson, J. C. 1998. Real strategies for virtual organizing. Sloan Management Review, 40(1): 33-45.

Von Hippel, E. 1988. The Sources of Innovation. New York: Oxford University Press.

Wallace, P. M. 1999. The Psychology of the Internet. New York: Cambridge University Press.

Walther, J. B. 1995. Relational aspects of computer-mediated communication: Experimental observations over time. Organization Science, 6(2): 186-203.

Wasko, M. & Faraj, S. 2000. It is what one does: Why people participate and help others in electronic communities of practice. Journal of Strategic Information Systems, 9(2-3): 155-173.

Wathne, K., Roos, J., & Krough, G. v. 1996. Towards a theory of knowledge transfer in a cooperative context. In G. v. Krogh & J. Roos (Eds.), Managing Knowledge Perspective on Cooperation and Competition, Vol. 1: 55-81. London: Sage.

Wellman, B. & Wortley, S. 1990. Different strokes for different folks: Community ties and social support. <u>American Journal of Sociology</u>, 96: 558-588.

Wellman, B., Salaff, J., Dimitrova, D., Garton, L., Gulia, M., & Haythornwaite, C. 1996. Computer networks as social networks: Collaborative work, telework, and virtual community. <u>Annual Review of Sociology</u>, 22: 213-238.

Wenger, E. 1998. <u>Communities of Practice</u>. Cambridge, UK: Cambridge University Press.

**APPENDIX A**
**Sample Characteristics**

|  | comp.lang.c++ | comp.databases | comp.object |
|---|---|---|---|
| Total number of messages posted | 9931 | 1196 | 3069 |
| Mean number messages per day | 199 | 24 | 61 |
| Total number of participants | 3444 | 832 | 603 |
| Mean number of participants per day | 69 | 17 | 12 |
| Average size of message (lines of text) | 36 | 32 | 44 |
| Average number of embedded lines | 11 | 7 | 14 |
| Number of discussion threads | 2951 | 649 | 358 |

**Results of Factor Analysis** [a]

| Constructs and Items | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 |
|---|---|---|---|---|---|---|---|---|
| **Social Affiliation** | | | | | | | | |
| To gain a feeling of belonging | .72 | | | | | | | |
| To meet new and different people | .81 | | | | | | | |
| To be socially competent and skillful | .69 | | | | | | | |
| To build friendships with others | .86 | | | | | | | |
| **Professional Affiliation** | | | | | | | | |
| To exchange advice and solutions with knowledgeable members of the group | | .74 | | | | | | |
| To keep abreast of new ideas and innovations | | .69 | | | | | | |
| To help other group members with their problems | | .70 | | | | | | |
| **Obligation** | | | | | | | | |
| Do you feel a sense of obligation to participate in the Newsgroup | | | .76 | | | | | |
| Do you feel responsible to help other group members | | | .79 | | | | | |
| Do you feel that other group members expect you to participate | | | .76 | | | | | |
| **Norms** | | | | | | | | |
| Are you aware of the Newsgroup's set of norms or rules for participation | | | | .92 | | | | |
| Are you aware of this Newsgroup's guidelines about appropriate behavior | | | | .93 | | | | |
| Does the Newsgroup have norms and expectations about what constitutes appropriate interaction | | | | .84 | | | | |
| **Trust** | | | | | | | | |
| Active group members are trustworthy in terms of the accuracy of the knowledge and information they provide | | | | | .86 | | | |
| I trust the quality of the information and knowledge provided by active group members | | | | | .90 | | | |
| If I share my technical problems with the group, I know active group members will respond constructively and caringly | | | | | .70 | | | |
| **Identification** | | | | | | | | |
| Would you feel a loss if you were no longer able to participate in the Newsgroup | | | | | | .85 | | |
| How strongly do you identify with this Newsgroup | | | | | | .75 | | |

[a] Factor loadings < .26 are not shown

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Acquisition** | | | | | | | | |
| Acquired knowledge that caused you to develop new insights | | | | | | | .84 | |
| Acquired knowledge that enabled you to perform new tasks | | | | | | | .89 | |
| **Contribution** | | | | | | | | |
| Contributed knowledge to this Newsgroup | | | | | | | | .88 |
| Contributed knowledge to other members that resulted in their development of new insights | | | | | | | | .88 |
| | | | | | | | | |
| Eigenvalue | 5.4 | 1.2 | 1.8 | 2.5 | 2.0 | .9 | 1.0 | 1.3 |
| Percentage of variance explained | 24.4 | 5.6 | 8.2 | 11.5 | 9.1 | 4.1 | 4.6 | 6.1 |

*Note*. Loadings smaller than .29 are not shown.

TABLE 1

**TABLE 1**
**Means, Standard Deviations, Reliabilities, and Correlations among Variables[a]**

| Variable | Mean | s.d. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Participation (log) | .57 | .89 | | | | | | | | | | |
| 2. Social affiliation | 2.13 | 1.23 | .01 | (.80) | | | | | | | | |
| 3. Professional affiliation | 5.56 | 1.24 | .10 | .20 | (.62) | | | | | | | |
| 4. Subject expertise | 4.53 | 1.73 | .16 | .01 | .20 | - | | | | | | |
| 5. Tenure in group (sqrt) | 3.29 | 2.17 | .20 | -.01 | .16 | .41 | - | | | | | |
| 6. Obligation | 2.69 | 1.37 | .06 | .33 | .31 | .17 | .12 | (.74) | | | | |
| 7. Norms | 4.47 | 1.85 | .18 | .07 | .18 | .25 | .27 | .17 | (.89) | | | |
| 8. Trust | 5.03 | 1.19 | .03 | .21 | .32 | .02 | .07 | .27 | .22 | (.80) | | |
| 9. Identification | 3.98 | 1.69 | .13 | .28 | .31 | .16 | .20 | .35 | .19 | .34 | (.71) | |
| 10. Knowledge contribution | 3.3 | 1.81 | .24 | .16 | .29 | .50 | .36 | .35 | .29 | .19 | .31 | (.85) |
| 11. Knowledge acquisition | 4.89 | 1.62 | .11 | .14 | .33 | .08 | .17 | .24 | .23 | .39 | .47 | .30 | (.88) |

[a] $N = 1023$. Correlations greater than .07 are significant at the $p < .05$ level. Correlations greater than .08 are significant at the $p < .01$ level. Cronbach's alphas appear on the diagonal for multiple-item measures.

TABLE 2
**Results of Hierarchical Regression Analyses for Knowledge Acquisition**

| | Model 1 - Groups & Participation | Model 2 – Motivation and Ability | Model 3 - Relational Capital |
|---|---|---|---|
| **Intercept** | ????? ? | 1.98 | .99 |
| **Controls** | ? | | |
| **Group 1** | .29 | .20 | .05 |
| **Group 2** | .58** | .56** | .17 |
| **Participation** | .18** | .09 | .04 |
| **Motivation and Ability** | | | |
| **Social Affiliation** | | .07 | -.09* |
| **Professional Affiliation** | | .41*** | .2*** |
| **Subject Expertise** | | -.07* | -.09** |
| **Tenure in Group** | | .11*** | .05* |
| **Relational Capital** | | | |
| **Obligation** | | | .05 |
| **Norms** | | | .08** |
| **Trust** | | | .26*** |
| **Identification** | | | .32*** |
| $R^2$ | .03 | .16 | .33 |
| $R^2$ **adj** | .02 | .15 | .32 |
| **F** | 7.04*** | 19.77*** | 33.10*** |
| **?$R^2$?** | | .13 | .17 |
| **F for ?$R^2$** | | 28.53*** | 47.76*** |

\* $p < .05$
\*\* $p < .01$
\*\*\* $p < .001$
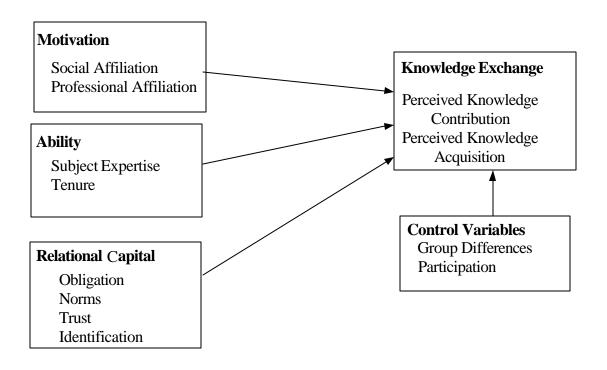Table entries are unstandardized coefficients

**TABLE 3**
**Results of Hierarchical Regression Analyses for Knowledge Contribution**

| | Model 1 – Groups & Participation | Model 2 – Motivation and Ability | Model 3 - Relational Capital |
|---|---|---|---|
| **Intercept** | ????? | -.29 | -.66 |
| | ? | | |
| **Controls** | ? | | |
| **Group 1** | -.18 | -.44* | -.42* |
| **Group 2** | -.43 | -.38* | -.50** |
| **Participation** | .53*** | .34*** | .3*** |
| | | | |
| **Motivation and Ability** | | | |
| **Social Affiliation** | | .20*** | .08 |
| **Professional Affiliation** | | .21*** | .1* |
| **Subject Expertise** | | .38*** | .35*** |
| **Tenure in Group** | | .1*** | .07* |
| | | | |
| **Relational Capital** | | | |
| **Obligation** | | | .22*** |
| **Norms** | | | .07* |
| **Trust** | | | .04 |
| **Identification** | | | .13*** |
| | | | |
| $R^2$ | .08 | .33 | .38 |
| $R^2$ adj | .08 | .32 | .37 |
| F | 22.97*** | 51.93*** | 41.23*** |
| $?R^2?$ | | .24 | .05 |
| F for $?R^2$ | | 67.52*** | 15.4*** |

* $p < .05$
** $p < .01$
*** $p < .001$
Table entries are unstandardized coefficients

**FIGURE 1**
**Theoretical Model - Role of Social Capital in Knowledge Exchange**



**Motivation**
　Social Affiliation
　Professional Affiliation

**Ability**
　Subject Expertise
　Tenure

**Relational Capital**
　Obligation
　Norms
　Trust
　Identification

**Knowledge Exchange**

Perceived Knowledge
　Contribution
Perceived Knowledge
　Acquisition

**Control Variables**
　Group Differences
　Participation