Team-Level Antecedents of Individuals’ Knowledge Networks*

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ABSTRACT

Individuals’ knowledge networks are widely considered to contribute substantially to the effectiveness and efficiency of organizations. While the positive effects of knowledge networks as a primary driver of social capital have recently received considerable research attention, potential determinants of individuals’ network building have not yet been adequately addressed. In this study, we investigate how certain team-level properties affect team members’ development of knowledge networks through the course of a team project. Using data from 430 team leaders and team members pertaining to 145 software development projects, we test cross-level hypotheses using hierarchical linear modeling (HLM). The results indicate that the team’s perception of the organizational knowledge-sharing climate, the team’s networking preference, and the team’s perceived importance of networking for project success positively affect individuals’ network building. Furthermore, a team’s perception of the adequacy of its technical competency and a team’s perception of the adequacy of its material resources inhibit team members’ individual network development. Theoretical and managerial implications are discussed.

Subject Areas: Hierarchical Linear Modeling, Innovation, Knowledge Networks, and Teams.

INTRODUCTION

Organizational researchers and practicing managers acknowledge the importance of social networks (i.e., individuals’ webs of personal relationships) to organizational effectiveness and efficiency. The density and the resourcefulness of an

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individual’s informal personal contacts (i.e., his or her knowledge network) are seen as important to a number of relevant outcomes including individual and team performance (Baldwin, Bedell, & Johnson, 1997; Mehra, Kilduff, & Brass, 2001), organizational assimilation and mentoring (Higgins & Kram, 2001), promotions (Burt, 1992; Seibert, Kraimer, & Liden, 2001), personnel retention (Alvesson, 2000), and power (Brass, 1984). In addition, research on downsizing attests to the crucial role of networks in organizations by demonstrating that disruption of knowledge networks can have damaging effects on the remaining organizational members’ effectiveness (Shah, 2000; Dess & Shaw, 2001).

Moreover, knowledge networks as a primary source of social capital, that is, the productive potential that is derived from the structure of relations between individual actors (Coleman, 1988), play a particularly important role in innovation and entrepreneurship (Ibarra, 1993; Chung & Gibbons, 1997; Young, Charns, & Shortell, 2001; Yli-Renko, Autio, & Sapienza, 2001). Networks allow knowledge transfer among teams, providing opportunities for learning and cooperation, while at the same time enabling the creation of new knowledge and enhancing the organization’s ability to innovate (Tsai & Goshal, 1998). These advantages occur because problem-solving in complex and uncertain innovation projects regularly involves project team members seeking and relying on team-external expertise, often located in other parts of the organization or in other organizational entities such as suppliers or customers. Thus, team members’ individual networks can provide access to useful resources. Such boundary spanning (Ancona & Caldwell, 1990, 1992) into knowledge networks is critical, as small project teams often cannot include all the expertise needed for a particular project. Similarly, individuals with a certain technical expertise may often need to serve various projects simultaneously, thus prohibiting organizations from assigning them full-time to a single project.

Furthermore, research conducted on the groupthink phenomenon has shown that integrating external knowledge and experience is an important component of effective decision making, particularly in teams with complex and uncertain, that is, innovative, tasks (Janis, 1995; Neck & Moorhead, 1995). In fact, some studies have shown that a large proportion of innovative ideas may originate from outside the firm (Carter & Williams, 1957; Myers & Marquis, 1969; Allen, Hyman, & Pinckney, 1983).

Although the literature offers ample indication of clear benefits to networking, researchers also point out that not all networking is desirable, and that it may depend upon the nature of the project (Allen, Tushman, & Lee, 1979). Development and maintenance of contacts can be time-consuming and may divert attention from performing productive activities or undermine group cohesion (Alderfer, 1976; Ancona, 1990). Additionally, networking that necessarily involves information transfer may result in critical breaches of confidentiality (Bouty, 2000). Furthermore, it is possible that not everyone should be networking. It may be preferable, for example, to have gatekeepers do all of the networking instead of having every team member engage in it (Tushman, 1977b).

While a considerable amount of research addresses the effects of knowledge networks on individual, group, and organizational outcomes, Mehra et al. (2001) correctly point out that antecedents of individuals’ networks in organizations need more attention in the literature. In this study we are interested in team-level
antecedents of knowledge networks. What team-level conditions influence individual team members’ knowledge network building? Answers to this question can move the study of social networks forward and provide recommendations for ways in which organizations can build and maintain social capital. Regardless of whether networks and networking are seen to have positive or negative effects on relevant outcomes, the results of this study apply to either situation. If networking is desirable for certain individuals, then managers can strive to enhance the positively related team-level antecedents for network building, and vice versa. Similarly, we study the building of new networks as opposed to the using of current networks because network building represents a change of knowledge capital within the workforce that managerial policies can bring forth.

Focusing the study on the team level as opposed to the organizational or other levels is important in the context of innovative tasks. Most innovative projects are conducted through teams, as teams provide the necessary closer coupling with other functional areas for successful project completion (Ancona, 1990). Because teams provide the most immediate contextual environment for individuals, they are likely to have important influences on their members. Our focus on team-level antecedents of individuals’ network building recognizes team design and management as an important source for growth of social capital in organizations. Thus, notwithstanding the likely influence of individual-level antecedents of individuals’ network building (e.g., social skills, organizational tenure), studying team-level antecedents of network building may provide important insights for the network-building phenomenon because organizations may be particularly able to impact those antecedents through their managerial policies, enhancing (inhibiting) them to encourage (discourage) network building. Furthermore, a review of the literature suggests that most studies have been conducted at other levels. For instance, researchers have investigated antecedents such as organizational structure (Leifer & Huber, 1977), departmental goals and technology (Keller & Holland, 1975), and individual hierarchical level (Aiken, Bacharach, & French, 1980).

In this paper, we investigate the network building of individuals participating in innovative team projects. Participation in such projects provides the opportunity for team members to establish new relationships with other team members (often from other disciplines or organizational units) or team-external contacts. While these “networking possibilities” exist with most innovative team projects, we argue that certain team-level characteristics facilitate individuals’ acquisition of new and resourceful relationships. Specifically, we hypothesize that team properties such as (1) perception of the strength of the organizational knowledge-sharing climate, (2) networking preference, (3) perceived importance of networking for project success, and (4) networking resources will be positively associated with individuals’ network building; contrarily, a team’s (5) perception of the adequacy of its technical competency and its (6) perception of the adequacy of its material resources are both expected to be negatively related to individuals’ network building due to less perceived need to network. These proposed cross-level relationships draw on the basic premise of system theory, recognizing the individual as an element within the context of his or her team. The team thereby represents a social system (McGrath, 1986) embodying certain networking-related norms and resources affecting the individual’s networking behaviors (Levine & Moreland, 1990).
This study has clear implications for knowledge management, which involves effective use of intellectual capacity, as well as effective generation and dissemination of information (Nonaka, 1994; Holsapple & Joshi, 2002). Our investigation of the development and growth of individuals’ knowledge networks is specifically related to three major elements of knowledge management: (1) information processing, (2) knowledge building, and (3) organizational memory. First, when individuals have wider communication channels or more of them, the transferability of critical information and knowledge in both intra- and interorganizational settings may be facilitated. Second, knowledge may be generated more readily with assistance provided through knowledge networks by sharing information and ideas (Nonaka, 1994). Third, while much knowledge may be written down or otherwise formally stored, other knowledge is stored informally through the collective memories of individuals (Nonaka, 1991). As such, the development and growth of knowledge networks will increase the likelihood that important information is passed on and remembered over time. Therefore, recognition of team-level antecedents of individuals’ knowledge networks can help managers encourage network building when appropriate, resulting in more efficient and effective knowledge management.

This research applies cross-level analysis to a large sample of organizational teams. In testing our hypotheses, we use hierarchical linear modeling (HLM) on data from 430 team leaders and members of 145 software development project teams from four different organizations.

BACKGROUND

Interest in studying why and how organizational members and organizations seek outside information to aid their projects is not new. Boundary spanning, which has also been considered vital to the innovation process (Tushman, 1977b), spurred a flurry of research in the 1970s and 1980s, particularly in research and development (R&D) labs (Hagstrom, 1965; Keller & Holland, 1975; Aldrich & Herker, 1977; Tushman, 1977a, b, 1979b, c; Cummings, 1978; Katz & Kahn, 1978; Allen et al., 1979; Roberts & O’Reilly, 1979; Katz & Tushman, 1981; Allen, 1984; Gladstein, 1984; Ancona & Caldwell, 1988; Ancona, 1990; Sundstrom, De Meuse, & Futrell, 1990). Interview data from Ancona & Caldwell (1988) suggest that product importance, novelty of task, cohesiveness, and deadlines may affect certain boundary-spanning activities. Ancona (1990) identified “probing teams” as those seeking outsiders, and those teams showed higher performance in that study. Researchers have also reported positive effects of internal communication on project performance (Allen, 1984; McGrath, 1984; Sundstrom et al., 1990).

Despite the large number of studies conducted on the boundary-spanning phenomenon, the aforementioned literature suggests that attention to potential team-level antecedents to network building has been sparse. We postulate that key team-level characteristics enhance or hinder individuals’ network building because teams have important influences on the team members (Ancona, 1990). Past research suggests that teams and groups develop norms about their tasks, interpersonal behavior, and group-interaction context quickly, sometimes in the first few minutes of their first meeting (Bettenhausen & Murnighan, 1985; Gersick, 1988).
Thus, team members bring scripts or schemas that they rely upon to determine the proper sequences of actions to follow (Abelson, 1976). As a consequence, team members, through mere participation in their teams and through interactions with each other (Blumer, 1969), help create a shared meaning that frames the boundary conditions of acceptable behaviors and norms that they enact.

In addition to helping shape their teams’ norms, there is ample evidence explaining why individuals respond strongly to these beliefs, norms, and values (Bandura, 1986). First, individuals have a natural need to belong to their work team by adapting to the norms and values of the team in order to avoid sanctions (Hollander & Willis, 1967). Second, and specifically for innovative projects, team members sometimes may not know how to address certain project dilemmas, and the team may provide the necessary informational structure. Thus, if team members rely on the team for problem solving, they are also more likely to respect team norms to be assured of future assistance when needed. Social interaction theory (Bandura, 1986) and its application to climates (Ashforth, 1985) suggest that the team members will interact to gather and interpret appropriate information. This interaction will most likely produce shared meaning about building and using networks, hence providing consensus in the face of ambiguity.

We therefore argue that teams develop similar norms and boundary conditions regarding individuals’ networking. In the next section, we discuss the six team-level characteristics investigated in this study and summarize their proposed relationships with individuals’ network building in the form of hypotheses.

Team’s Perception of the Strength of the Organizational Knowledge-Sharing Climate

Information gathering and sharing represents an important aspect of successful project completion, especially for organizations heavily involved with innovative projects (Hansen, 1999). Through networking, in particular, organizations and teams within organizations can access valuable information and knowledge (Berg, Duncan, & Friedman, 1982), as well as complementary skills (Arora & Gambardella, 1990). Furthermore, networks can also provide organizations with critical information regarding relevant developments in different technologies (Freeman, 1982), thus providing for a more accurate assessment of the field. In addition, through networks and information sharing, projects can be more effective because of timely integration of knowledge across organizational boundaries (Eisenhardt & Tabrizi, 1995; Szulanski, 1996).

Common practices, beliefs, and procedures that an organization follows comprise an organizational climate (Schneider, 1983). Organizations typically have numerous climates, “as many climates as there are psychologically connected clusters of events, practices and procedures” (Schneider, 1983, p. 109). We define a knowledge-sharing climate as the set of shared understandings about providing employees access to relevant information as well as building and using knowledge networks within organizations. This can include training and technical consultation (Gladstein, 1984). We would anticipate the knowledge-sharing climates of most firms to be primarily consisting of networking components, as opposed to information dissemination through the written word only. Researchers have found that
technology transfer primarily occurs via informal communication channels as opposed to formal documentation (Allen et al., 1983). This reinforces the importance of knowledge networks for individuals to acquire new knowledge.

As team members encounter project-related problems, they will be faced with such questions as “Do we possess all necessary knowledge and skills to bring this project to successful completion?” and “Do we need outside assistance to solve this problem?” As team members try to answer these questions, their networking behaviors are going to rely on their perception of the knowledge-sharing climate. If the organization generally encourages knowledge sharing (i.e., strong knowledge-sharing climate), team members are more likely to seek out external assistance. Conversely, if the knowledge-sharing climate is relatively weak or inexistent, team members are less likely to perceive network building as a possible solution to their problems.

Research consistently shows that perceptions of organizational climate can vary by work groups, job types, and other collectives within organizations (Dansereau & Alluto, 1990). We postulate that individuals’ network building will depend on the strength of their respective team’s perception of the organizational knowledge-sharing climate. If the team assesses a strong organizational knowledge-sharing climate, then team members will receive a clear signal that it is acceptable or desirable to seek out and build networks of contacts to gather needed knowledge. In contrast, if the team assesses a weak organizational knowledge-sharing climate, perhaps because the organization is fostering a sense of competition and secrecy (Hansen, 1999), then individuals will perceive a lower need to build networks. Consequently, we hypothesize that:

H1: A team’s perception of the strength of the organizational knowledge-sharing climate is positively related to its members’ extent of network building.

**Team’s Level of Networking Preference**

Teams differ regarding their general preference to use networks to solve problems. Some groups realize that they must actively manage their external relations because they may depend upon outsiders for information or resources (Pfeffer, 1986), while others may only rely on their own knowledge. Types of interactions with outsiders can cover the spectrum of meetings, one-on-one discussions, phone calls, and computer messages (Ancona & Caldwell, 1988). Ancona and Caldwell (1988) classify activity sets used for dealing with outsiders as “scout,” “ambassador,” “sentry,” “guard,” “immigrant,” “captive,” and “emigrant.”

We define the level of network preference as *high* if the general (i.e., not project-specific) motivation of team members to develop networks and work with colleagues from different disciplines and organizations is strong. Teams may develop high networking preference for a variety of reasons. For example, teams may have a high networking preference depending on whether the team leaders promote high levels of communication with the outside environment to obtain information on the stage of work activities (Hackman & Walton, 1986; Ancona, 1990), and also on the environment (Gersick, 1988).
We argue that the team’s networking preference is a team-level predictor of individual team members’ network building. Social interaction theory (Bandura, 1986) suggests that, if a team has a high level of network preference, then individuals will also perceive a strong need to build networks. In contrast, teams with a low network preference level might be permeated with “not invented here” attitudes among its members (Katz & Allen, 1982), and thus might be less likely to perceive the need to build networks.

Our predictions are consistent with Ancona’s (1990) study of teams and the strategies they use to interact with the environment. For instance, she found that the team leader and members of “informing” teams were content to rely upon internal information to understand their environment. These teams had very low network preference and thus had minimal need for interaction with their external environment to search for information. In contrast, the “probing teams” had high network preference and had a very high level of interaction with their external environment to seek information. Thus, we hypothesize that:

H2: A team’s level of networking preference is positively related to its members’ extent of network building.

Team’s Perceived Importance of Networking for Project Success
Teams differ in their project-specific awareness regarding the importance of the use of networks. We describe a team’s perceived importance of networking for project success as high if its members attach a strong importance to the use of external contacts to complete a given (i.e., specific) project successfully. Teams may perceive networking as consequential if the product or task is “important” or “revolutionary” (Ancona & Caldwell, 1988). Outside sources have been shown to be particularly useful for projects needing “new ideas” or “new approaches” (Utterback, 1971). Environmental uncertainty may also increase the perception of networking importance (Keller & Holland, 1975; Leifer & Huber, 1977; Tushman, 1979a), although the response could depend upon the industry (Hrebiniak & Snow, 1980). The literature suggests that a changing environment increases the need for effective communication with that environment (Burns & Stalker, 1966; Aiken & Hage, 1971).

It is important to note that our second and third constructs may not occur for a given team project in the same direction. As one possible example, team members generally may prefer not to interact and network with colleagues from outside the team or from other organizational units (i.e., low network preference); however, at the same time, they may recognize that for optimal results on the current project, they will need to draw on team-external knowledge and resources from across the organization (i.e., high perceived importance of networking for project success). For instance, for highly exploratory projects, little existing knowledge may be relevant and the team has no choice but to gather new information and knowledge from outside sources to complete the project at hand (Levinthal, 1997).

We argue that the perceived importance of networking for project success is a team-level predictor of individual team members’ network building. If at the team level, team members agree on the importance or necessity of using networks to collect, for instance, team-external expertise, feedback, or resources (i.e., high
perceived importance of networking for project success), then individual members are more likely to build networks. Building such networks may be necessary for the team to foster the knowledge variety required for the project at hand (McGrath, 2001). In other cases, the team may believe that it has all of the knowledge it needs and has little use for networks and outside assistance (Levinthal, 1997), thus inhibiting its individual members’ network building. Thus, we hypothesize that:

H3: A team’s perceived importance of networking for project success is positively related to its members’ extent of network building.

Team’s Networking Resources
Similar to organizations (Ahuja, 2000), teams can have a number of direct and indirect ties to other teams and individuals. These linkages can play a critical role in providing knowledge and expertise (Berg et al., 1982) to which the team would not otherwise have access. Through such relations, teams can learn about opportunities for knowledge use and have access to valuable knowledge (Hansen, 1999). As such, through their teams, individual team members have certain network ties at the outset of a project. These ties may be particularly introduced by team members who have had previous roles as “stars,” “gatekeepers,” or “liaisons” in other groups (Allen & Cohen, 1969; Tushman, 1977a, 1979b, c; Katz & Tushman, 1981; Allen, 1984; Ancona & Caldwell, 1988), especially for “locally-oriented” teams (Tushman & Katz, 1980).

The aggregate of all team members’ knowledge networks is what we refer to as a team’s networking resources. The more nonredundant team-external network ties are brought to the team at the outset by its members, the stronger the team’s networking resources. We argue that strong team networking resources will lead to a better ability of team members to build their own individual networks because they can more easily draw on their team members’ existing contacts. In such a team, it is likely for networking resources (i.e., useful team-external contacts) to be transferred from one team member to other team members during the course of a project as team members attend meetings with team-external contacts and as information about useful contacts is shared in team discussions (Burt, 1992). In contrast, individuals in teams with weak networking resources lack the same opportunities to access resourceful contacts. These team members may have difficulty readily amassing and processing possible opportunities for further network building because exhaustive intra-organizational searches can be very time-consuming and overwhelming (Hansen, 1999). Thus, those teams with fewer ties (i.e., network resources) provide fewer opportunities for individuals to build their networks. Hence, we hypothesize that:

H4: A team’s strength of networking resources is positively related to its members’ extent of network building.

Team’s Technical Competency and Material Resources
As team members assess the task requirements of their project, they individually and collectively assess the resources provided, both in terms of technical competency as well as financial and material resources, in relation to the challenges the
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project poses. Through this interactive process (Bandura, 1986), the team develops a sense of potency or efficacy (Shea & Guzzo, 1987; Whitney, 1994; Gibson, Randel, & Early, 2000) with regard to the project task, resulting in an assessment of how much, if any, outside help or additional financial and material resources are needed for successful project completion. Such collective assessment, regardless of whether objectively correct, is likely to influence team members’ motivation to seek and develop ties with individuals outside the team in order to further the project. If the team consensus establishes that the team essentially has all the technical competency and material resources needed, team members are less likely to pursue (team-external) network-building activities. Gladstein (1984), for example, found a negative relationship between boundary spanning and skill adequacy. Similarly, Levinthal (1997) found that when an organization’s members believe that they have the necessary organizational knowledge to understand and complete their projects, they are more likely to optimize performance without any outside assistance. Correspondingly, if the team establishes that it lacks important competencies or resources, team members are more likely to engage in seeking useful contacts to remedy the perceived deficit. Hence, we hypothesize that:

H5: A team’s perception of the adequacy of its technical competency is negatively related to its members’ extent of network building.

H6: A team’s perception of the adequacy of its material resources is negatively related to its members’ extent of network building.

METHODS

Sample and Data Collection

A total of 145 software development teams from four German software development laboratories participated in this research. All four laboratories were part of larger organizations, with two of them being independent operations of the same U.S. parent company. The other two laboratories belonged to organizations headquartered in Germany. Each laboratory employed between 100 and 500 software developers. Table 1 provides an overview of the number of project teams surveyed, the average team size, and the type of software project (i.e., the development of a primarily new software solution versus the upgrade or customization of an existing software). The table also contains the mean values of this study’s main variables by laboratory as well as the ANOVA results testing for significant differences in means.

The laboratories provided names and contact information of project team members, and they informed their employees that a study about team management was forthcoming. All team leaders, as well as randomly chosen team members, were contacted for interview appointments. Respondents’ participation in this study was strictly voluntary. All contacted respondents were interviewed. Data were gathered through individual interviews using a fully standardized questionnaire containing five-point Likert-type scales. All projects were completed at the time of data collection.
Table 1: Laboratory descriptives, variable means by laboratory, ANOVA.

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Lab 1*</th>
<th>Lab 2*</th>
<th>Lab 3*</th>
<th>Lab 4*</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of software developers (approx.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>No. of projects in sample</td>
<td>145</td>
<td>32</td>
<td>27</td>
<td>63</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of software development</td>
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<tr>
<td>New software solution</td>
<td>62</td>
<td>9</td>
<td>11</td>
<td>26</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upgrade/Customization</td>
<td>83</td>
<td>23</td>
<td>16</td>
<td>37</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team size (mean/SD)</td>
<td>6.3/2.9</td>
<td>7.3/4.1</td>
<td>6.4/2.2</td>
<td>6.2/2.4</td>
<td>5.5/2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team’s perception of the organizational knowledge-sharing climate</td>
<td>3.92</td>
<td>4.17</td>
<td>3.90</td>
<td>3.89</td>
<td>3.68</td>
<td>5.51</td>
<td>.00</td>
</tr>
<tr>
<td>Team’s networking preference</td>
<td>3.66</td>
<td>3.84</td>
<td>3.77</td>
<td>3.57</td>
<td>3.53</td>
<td>2.96</td>
<td>.03</td>
</tr>
<tr>
<td>Team’s perceived importance of networking for project success</td>
<td>3.17</td>
<td>3.34</td>
<td>3.30</td>
<td>3.20</td>
<td>2.67</td>
<td>6.22</td>
<td>.00</td>
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<tr>
<td>Team’s networking resources</td>
<td>3.57</td>
<td>3.87</td>
<td>3.89</td>
<td>3.28</td>
<td>3.57</td>
<td>8.90</td>
<td>.00</td>
</tr>
<tr>
<td>Team’s technical competency</td>
<td>4.09</td>
<td>4.01</td>
<td>3.93</td>
<td>4.27</td>
<td>3.93</td>
<td>4.85</td>
<td>.00</td>
</tr>
<tr>
<td>Team’s material resources</td>
<td>3.87</td>
<td>3.52</td>
<td>3.60</td>
<td>4.19</td>
<td>3.83</td>
<td>12.97</td>
<td>.00</td>
</tr>
<tr>
<td>Individuals’ network building</td>
<td>3.07</td>
<td>3.32</td>
<td>3.48</td>
<td>2.86</td>
<td>2.80</td>
<td>5.97</td>
<td>.00</td>
</tr>
</tbody>
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Note: Team-level mean values on a 5-point rating scale, with 1 being lowest and 5 being highest.

*U.S. parent company.
**German parent company.

All interviews were conducted on-site in dedicated interview rooms assuring similar conditions for every interview. The interviews followed a very structured pattern. First, the respondent confirmed team membership, and we ensured that all respondents of one team were referring to the same set of individuals as composing the team. The respondent then read and completed the questionnaire by himself or herself. Thus, possible interviewer effects were minimized, while there was still an interviewer present to clarify questions if any occurred. Each interview lasted approximately 45 minutes. A total of 430 interviews with members and leaders referring to 145 software development teams were conducted. To obtain more reliable ratings of the team-level constructs under consideration, multiple (average three) respondents from each team participated, one of whom was the team leader. Of the team members and leaders, 22% were female. Our sample contained 26% female respondents. The teams in this sample averaged 6.3 members (median = 6, standard deviation = 3), with an average age of all team members of 36.6 years (median = 36, standard deviation = 5).

Measures

The German language measurement scales were specifically generated for the present study based on descriptions and measures of related constructs in the literature (Litwin & Stringer, 1968; Keller & Holland, 1975; Tushman, 1977b;
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Allen et al., 1979; Hackman, 1987; Ancona, 1990; Denison, Hart & Kahn, 1996; Sparrowe, Linden, Wayne, & Kraimer, 2001). In developing these scales, we followed Churchill’s (1979) and Bagozzi’s (1994) suggestions for developing measures. All items for our measures were generated based on a thorough literature review. A pretest was then conducted using the initial list of items on 23 members of product development teams at a machine tool manufacturing company. Some items were deleted and the wording of others was refined as a result of the pretest. A questionnaire with a refined list of items was then used to collect data from 430 team leaders and members. We took every step necessary to assess the reliability and internal consistency of our data (Cronbach’s alpha are reported later). Thus, all constructs included in our analyses were measured using multiple items and are described more fully below. Additionally, translations (from German) of the scales used are included in the appendix of this article.

Team-level independent variables

Data for the team-level independent variables were gathered through the assessment of multiple team members responding to items formulated explicitly at the team level. Thus, when rating these items, the respondents were asked to refer to the team as a unit.

First, we measured the team’s perception of the strength of the organizational knowledge-sharing climate with three items referring to the accessibility of important contacts or data within the organization, as well as the willingness of team-external colleagues to share knowledge and experiences (Hansen, 1999). Second, we measured the team’s level of networking preference with two items referring to team members’ general motivation to collaborate with people from other disciplines, functional areas, or organizations (Ancona, 1990). Third, we assessed the team’s perceived importance of networking for project success with three items pertaining to the team’s perception of the necessity to interact with team-external contacts to acquire knowledge, work contributions, or feedback (Tushman, 1977b; Ancona, 1990). Fourth, a three-item scale measured the team’s strength of networking resources, including items that assessed the degree to which the team members had useful team-external contacts going into the project (Denison et al., 1996). Fifth, four items relating to programming skills, expertise with the application field of the software, software and hardware skills, and other skills comprised the team’s perception of the adequacy of its technical competency (Hackman, 1987). The fourth item in this scale (15) was designed to cover nonsoftware-specific skills such as project management skills (Allen et al., 1979). Sixth, two items measured the team’s perceived adequacy of material resources, including the amount of the project budget (Denison et al., 1996).

To test the reliability and validity of the measurement scales of the six independent variables, we conducted exploratory factor analysis and confirmatory factor analysis including all 17 items. The exploratory factor analysis (principal components method with varimax rotation) resulted in a six-factor solution with the items loading strongly on their respective constructs. As Table 2 documents, the items show clean loadings on the six constructs.

Furthermore, we conducted a confirmatory factor analysis. The findings provide support for all six measurement scales. As documented in Table 3, all items
Table 2: Exploratory factor analysis of team-level measures.

<table>
<thead>
<tr>
<th>Item</th>
<th>Team’s Perception of Organizational Knowledge- Sharing Climate</th>
<th>Team’s Networking Preference</th>
<th>Team’s Perceived Importance of Networking for Project Success</th>
<th>Team’s Networking Resources</th>
<th>Team’s Technical Competency</th>
<th>Team’s Material Resources</th>
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</tbody>
</table>

Extraction method: Principal Component Analysis.
Rotation method: Varimax with Kaiser Normalization.

show significant factor loadings (as indicated by t-values greater than 1.96) and the scales have satisfactory composite reliability ranging between .77 and .91 (Fornell & Larcker, 1981; Bagozzi & Yi, 1988; Bagozzi, 1994). With the greatest common variance between the estimated factors at .32, the larger composite reliabilities indicate strong discriminant validity, supporting the findings from the exploratory factor analysis.

Before aggregating multiple team members’ evaluations of the team-level independent variables, we assessed interrater agreement (James, 1982; James, Demaree, & Wolf, 1984; Campion, Medsker, & Higgins, 1993) using the multiple-item estimator for within-group interrater reliability as proposed by James et al. (1984). This test yielded results indicating generally very strong agreement of ratings referring to the same team. Table 4 provides the average scores of this test (IRR) across all teams. Given this homogeneity of within-team ratings, we aggregated team data by calculating the arithmetic mean.

**Individual-level dependent variable**

Each individual’s extent of network building was measured using four items assessing the individual respondent’s perception of the extent to which the project enabled him or her to gain new useful personal contacts through the course of this
Table 3: Confirmatory factor analysis of team-level measures.

<table>
<thead>
<tr>
<th>Factor Loading (1)</th>
<th>t-Value (2)</th>
<th>Variance Extracted (3)</th>
<th>Composite Reliability (4)</th>
<th>Common Variance with other Factors (5)</th>
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<tr>
<td>Item 1</td>
<td>.68</td>
<td>–</td>
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<td>Item 2</td>
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<td>6.78</td>
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<td>.80</td>
<td>7.16</td>
<td>.64</td>
<td></td>
</tr>
<tr>
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<td>.91</td>
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<td>Item 7</td>
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<td>Item 13</td>
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<td>.40</td>
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<td>Item 14</td>
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<td>8.01</td>
<td>.53</td>
<td>.08</td>
</tr>
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<td>Item 15</td>
<td>.67</td>
<td>7.46</td>
<td>.45</td>
<td>.00</td>
</tr>
<tr>
<td>Item 16</td>
<td>.72</td>
<td>–</td>
<td>.52</td>
<td>.85</td>
</tr>
<tr>
<td>Item 17</td>
<td>.82</td>
<td>5.14</td>
<td>.67</td>
<td>.14</td>
</tr>
</tbody>
</table>

Method of estimation: Maximum Likelihood.

*a*Calculated based on CFA factor estimates.
project (Sparrowe et al., 2001). The items refer to contacts within and outside the respondent’s immediate organizational unit, including contacts outside the company. All items were formulated on the individual level, asking the respondents to relate to their own situation, rather than to the team’s overall situation.

Table 4 provides descriptive statistics on all measurement scales as well as correlations between all constructs on the team level (N = 145), that is, using a team-level aggregation of the individuals’ network building variable. All measurement scales for the team-level independent variables show acceptable internal consistency, as represented by Cronbach’s alpha reliability coefficients. In all cases, alpha exceeds .70, thus demonstrating adequate reliabilities (Nunnally, 1978; Bagozzi, 1994). We combined items pertaining to one construct by calculating the arithmetic mean of those items.

Control variables

We also included two team-level control variables: team size and project type. We were unclear on how size would impact the results, but we reasoned that the larger the size of a team, the more opportunities individual team members have to form networks. Others might argue that a larger team size would increase the chance of finding answers within the team, thus decreasing the need for outside networking. However, large teams may have so many members because their tasks are more complex, and this increased task complexity might increase the need for networking (Ancona & Caldwell, 1988).

In addition, we included a dummy variable to differentiate between new software projects and upgrade projects. This categorization was based on the team leaders’ assessments of whether their projects involved primarily the design and development of new software solutions (more innovative), or primarily the upgrade or customization of existing software solutions (less innovative). We suspected that individuals in teams involved with the more innovative new software projects might have a greater inclination and more opportunity to build networks (Hackman, Brousseau, & Weiss, 1976), given the highly complex and uncertain nature of the task. This line of reasoning is related to the Allen et al. (1979) study showing that the more innovative research projects performed best when all group members networked, but the comparatively less innovative product and process development projects worked best for groups with only a few members networking.

Given that this study includes data from four different software development laboratories and given the significant mean differences found on all of this study’s main variables (see Table 1), we are controlling for possible organizational effects (i.e., dependencies between observations from one laboratory) in our
Table 4: Descriptive statistics and intercorrelations.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Items</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Alpha</th>
<th>IRR(^a)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
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<td>(1) Team’s Perception of the Organizational Knowledge-Sharing Climate</td>
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<td>3.92</td>
<td>.48</td>
<td>.77</td>
<td>.82</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Teams’ Networking Preference</td>
<td>2</td>
<td>3.66</td>
<td>.51</td>
<td>.76</td>
<td>.77</td>
<td>.32**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Team’s Perceived Importance of Networking for Project Success</td>
<td>3</td>
<td>3.17</td>
<td>.65</td>
<td>.72</td>
<td>.76</td>
<td>.10</td>
<td>.32**</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(4) Team’s Networking Resources</td>
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<td>3.57</td>
<td>.69</td>
<td>.72</td>
<td>.80</td>
<td>.37**</td>
<td>.31**</td>
<td>.38**</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(5) Team’s Technical Competency</td>
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<td>4.09</td>
<td>.51</td>
<td>.80</td>
<td>.90</td>
<td>.21*</td>
<td>.04</td>
<td>-.21*</td>
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<td>(6) Team’s Material Resources</td>
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<td>.00</td>
<td>-.13</td>
<td>.00</td>
<td>.39**</td>
<td></td>
</tr>
<tr>
<td>(7) Individuals’ Network Building</td>
<td>4</td>
<td>3.07</td>
<td>.83</td>
<td>.86</td>
<td>.72</td>
<td>.21*</td>
<td>.43**</td>
<td>.51**</td>
<td>.36**</td>
<td>-.33**</td>
<td>-.24**</td>
</tr>
</tbody>
</table>

\(^a\) = Coefficient of Inter-rater Reliability (James et al., 1984).

** = Correlation is significant at the 0.01 level (2-tailed).

* = Correlation is significant at the 0.05 level (2-tailed).
analysis. Specifically, we have regressed the independent variables and the dependent variable on laboratory and saved the standardized residuals. We have used the standardized residuals from this procedure (“purified” from organizational effects) as the basis for further analysis. This procedure effectively controls for all constant and unmeasured differences across the laboratories that may explain differences in the variables and relationships investigated.

Hierarchical Linear Modeling (HLM)

The hypotheses of the present study require testing the effects of team-level properties (e.g., team’s networking preference, team’s networking resources) on individual-level outcomes (i.e., individuals’ network building). Some authors suggest that the use of traditional statistical techniques in such cross-level studies may prove inadequate (Bryk & Raudenbush, 1989; Rousseau, 1985). Consequently, we used hierarchical linear modeling (HLM), a statistical technique that is gaining increased acceptance in the management literature (Hoffmann, Griffin, & Gavin, 2000; Whitener, 2001), to address our cross-level relationships. Although there are other statistical packages available to test multilevel hypotheses (e.g., LISREL, ML2, SAS Proc Mixed), we preferred HLM because it has been used more extensively for such purposes than other techniques (Bryk & Raudenbush, 2002). HLM resolves the various problems inherent with the traditional regression methods of dealing with cross-level issues such as aggregation and disaggregation bias, misestimated precision and unit of analysis problems (Bryk & Raudenbush, 2002). With HLM, one can readily test hypotheses between levels of analysis and partition explained variances from each level.

Formulation of the HLM model

The use of HLM requires a distinction between individual-level variables and other higher levels (e.g., team or organizational properties). Because we test the effects of team properties on individual-level variables, our model consists of two levels. At Level 1, the “micro-level model,” the units are individuals and each person’s outcomes are represented as a function of a set of individual characteristics. The parameters (intercept and slope) explaining the relationships at Level 1 become the dependent variables for the Level 2 model. The Level 2 model is an “intercept-as-outcome model” with Level 1 covariates. In this model, the intercepts of separate individual-level regressions by team on the control variables become the dependent measures for equations using team properties as independent variables. This model is preferred when the interest is in the main effects of team-level variables on the dependent variables. Slopes-as-outcomes models address the issue of whether the context moderates the relationships between the individual-level predictors and the dependent variables. However, given that our study did not include any individual-level independent variables, only intercept-as-outcome models were used.

Individual-Level Model (Level 1). Because individuals’ network building is the dependent variable of interest in the present study, we denote the network building of person $i$ in team $j$ as $Y_{ij}$. This outcome is then typically represented as
a function of individual characteristics $X_{ij}$ and a model error $r_{ij}$. However, because our study does not include individual characteristics, the Level 1 model is:

$$Y_{ij} = \beta_{0j} + r_{ij}$$  \hspace{1cm} (1)

where $Y_{ij}$ is the network building for individual $i$ in team $j$, and $\beta_{0j}$ is the average network building level in team $j$.

**Team-Level Model (Level 2).** After the formulation of the Level 1 model, it is necessary to construct a Level 2 model. The Level 2 model explains the impact of the team factors on the mean level of individuals’ network building on each team. Consistent with HLM procedures (Bryk & Raudenbush, 2002), the individual effects, represented by the micro-level coefficient $\beta$, are presumed to vary across teams. Therefore, a between-team or macro-level model can be formulated where the $\beta$s are conceived as outcome variables that depend on a set of team-level variables. Formally, the macro-level model is formulated as follows:

$$\beta_{0j} = \gamma_0 + \gamma_1 W_{1j} + \gamma_2 W_{2j} + \cdots + \gamma_S W_{sj} + U_{0j}$$  \hspace{1cm} (2)

where $\beta_{0j}$ is the average network building in team $j$, $\gamma_s$ are the coefficients that capture the effects of team variables $W_{sj}$ ($s = 1, \ldots, S$) (i.e., knowledge-sharing climate, networking preference, etc.) on the within-team levels represented by $\beta_{0j}$, and $U_{0j}$ are the unique effects associated with team $j$.

**RESULTS**

We used procedures outlined by Bryk & Raudenbush (1992, p. 62) to first determine whether there is a significant between-team variation in individuals’ network building. This is a necessary condition that needs to be satisfied before we can test the specific hypotheses. By running a null model with only individual-level variables, we are actually performing an ANOVA test to determine whether the between-team differences in individuals’ network building are larger than the within-team differences (Bryk & Raudenbush, 1992, p. 33). The between-team variance in network building ($\tau_{00}$) was .584. The within-team variance ($\sigma^2$) was .995. These estimates suggest that the between-team variance was 37% of the total variance in individuals’ network building, indicating the importance of studying team-level variables as determinants of individuals’ network building.

Table 5 reports the HLM coefficients of all team-level predictors of individuals’ network building.

The analysis supports five of our six hypotheses, with the following team-level predictors showing significant relationships with individuals’ network building: team’s perception of the organizational knowledge-sharing climate (Hypothesis 1; std. coef. $= .10$, $p = .08$), team’s networking preference (Hypothesis 2; std. coef. $= .17$, $p = .00$), team’s perceived importance of networking for project success (Hypothesis 3; std. coef. $= .20$, $p = .00$), team’s technical competency (Hypothesis 5; std. coef. $= -.15$, $p = .01$), team’s material resources (Hypothesis 6; std. coef. $= -.10$, $p = .08$). Contrary to Hypothesis 4, however, a team’s strength of networking resources, that is, the number of valuable network ties already present in a team, did not, in the multivariate HLM analysis, show a significant influence on individual team members’ ability to build their knowledge networks. While showing
Table 5: Results of hierarchical linear modeling.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Team-Level Predictors</th>
<th>Standardized Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Team’s Perception of the Organizational Knowledge-Sharing Climate</td>
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<td>.08</td>
</tr>
<tr>
<td>H2</td>
<td>Teams’ Networking Preference</td>
<td>.17</td>
<td>.00</td>
</tr>
<tr>
<td>H3</td>
<td>Team’s Perceived Importance of Networking for Project Success</td>
<td>.20</td>
<td>.00</td>
</tr>
<tr>
<td>H4</td>
<td>Team’s Networking Resources</td>
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<td>.42</td>
</tr>
<tr>
<td>H5</td>
<td>Team’s Technical Competency</td>
<td>−.15</td>
<td>.01</td>
</tr>
<tr>
<td>H6</td>
<td>Team’s Material Resources</td>
<td>−.10</td>
<td>.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Team-Level Control Variables</th>
<th>Standardized Coefficient</th>
<th>P-Value</th>
</tr>
</thead>
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<td></td>
<td>Team Size</td>
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<td>.35</td>
</tr>
<tr>
<td></td>
<td>Project Type (New vs. Upgrade)</td>
<td>.18</td>
<td>.06</td>
</tr>
</tbody>
</table>

a strong bivariate correlation with the team-level aggregation of individuals’ network building (r = .36, p = .00), team’s strength of networking resources failed to show a significant effect on individuals’ network building when controlling for the other team-level predictors included in this study. Finally, Table 5 also shows that of the two team-level control variables only project type had a significant influence (std. coef. = .18, p = .06) on individuals’ network building. This indicates that projects involving the development of new software solutions (versus upgrade and customization projects) offer a better environment for team members to develop their individual knowledge networks, lending support to related research by Hackman et al. (1976) and Allen et al. (1979).

DISCUSSION

The overarching objective of this study was to investigate team-level properties as determinants of individuals’ network building. We proposed positive relationships between four team-level properties (i.e., organizational knowledge-sharing climate, networking preference, perceived importance of networking for project success, and networking resources) and individuals’ network building. Furthermore, we hypothesized negative relationships between the teams’ perception of the adequacy of both their technical and material resources and individuals’ network building. Using hierarchical linear modeling to avoid errors committed with traditional techniques, our study provides strong support for all but one of our hypotheses. In general, the study does provide evidence for strong team-level effects on individuals’ network building.

This study’s results have clear implications for knowledge management in organizations. We consider several team-level elements that help explain individuals’ knowledge network building, thus contributing to a better understanding of how organizations manage their knowledge resources and subsequently foster their capabilities for developing and leveraging critical organizational knowledge (Nonaka, 1991). Specifically, knowledge management involves the development of both formal, potentially noninterpersonal, storage and retrieval of organizational information as well as informal knowledge generation and dissemination of knowledge.
among organizational members (Holsapple & Joshi, 2002). The latter (more informal) component is potentially more difficult to manage than the former (more formal) component, because it relies upon a significant degree of individuals’ motivation and cooperation to complete. The growth of individuals’ knowledge networks will generally ease the task of knowledge generation and dissemination throughout an organization by widening existing communication channels and increasing the number of different communication channels. Therefore, the fostering of team-level antecedents of knowledge networks provides important preconditions for effective knowledge management within organizations.

Theoretical Implications

This research was based on the premises that (1) individuals’ knowledge networks can be important for the sustained success of innovative organizations (such as R&D laboratories), and (2) many such organizations today are using project teams as their primary work units. While previous research has focused on the effects of knowledge networks in organizations (Ibarra, 1993; Chung & Gibbons, 1997; Baron & Markman, 2000; Young et al., 2001; Yli-Renko et al., 2001), our study addresses critical team-level antecedents of individuals’ network building. Of course, team-level properties cannot be expected to account for 100% of the variance, as such obvious individual-level factors as social skills and network knowledge will have effects as well. Nevertheless, 37% of the variance of individuals’ network building in our data was between teams, making the focus on team-level determinants a quite powerful one. Omission from our analysis of possible individual-level antecedents like social skills is not expected to have any significant influence on the results of this research.

The findings of this study contribute significantly to the network literature that has focused primarily on the effects of networks at the expense of understanding how these networks emerge. By specifying critical team-level antecedents of individuals’ network building, we show that individuals in teams with strong positive perceptions of the organizational knowledge-sharing climate are having a higher propensity to build networks. Similarly, individuals in teams that have a general preference for networks as well as a high perceived importance of networking for project success are also more likely to build networks.

Contrary to our hypothesis (H4), a team’s level of networking resources did not show a significant relationship with individuals’ network building in the multivariate HLM analysis. We surmise that the potentially easier access to outside resources might be partially offset by a desire to delegate networking responsibilities to team members who already have established networks. For example, a team member might think, “Why should I work to build my own contacts when my teammates already have them?” This lends additional support to the establishment of certain communication roles like stars, gatekeepers, and liaisons within groups (Tushman, 1977a, 1979b, c; Katz & Tushman, 1981; Allen, 1984; Ancona & Caldwell, 1988), and the decision by other group members to leave network building to them.

Given the sparseness of research on factors that may hinder individuals’ network building (Sparrowe et al., 2001), our study also contributes to the literature by investigating such potential team-level hindrance factors. Specifically, we provide
evidence that, if teams perceive that they have adequate technical and material resources, individual team members are less likely to build networks. It appears that, just as there are team-level properties that promote individuals’ network building, there are also team-level factors that discourage such behaviors. Moreover, we show that hindrance factors are not primarily limited to behavioral aspects (e.g., uncooperative group members, Sparrowe et al., 2001).

Our findings regarding the two team-level control variables are also worth noting. Team size did not show a significant effect on individuals’ network building in the multivariate HLM analysis, implying that the above-mentioned team-level antecedents impact networking in both large and small teams. However, our results for project type show that more innovative projects (new software solutions versus upgrade or customization) are more likely to positively influence individuals’ network building. These results parallel research relating project innovativeness and networking (Hackman et al., 1976; Allen et al., 1979).

Managerial Implications

The results of this empirical investigation offer lessons to organizations on how to foster the development of knowledge networks through team projects.

First, team-based innovative organizations need to stress to their members the importance of knowledge networks to the sustainable effectiveness and efficiency of the organization. Team leaders and team members must be made aware that boundary spanning (Ancona & Caldwell, 1990, 1992) to acquire task information; to get outside advice on task issues; to acquire material resources; to coordinate team-external contributions; or to solicit feedback from customers, management, or other colleagues not only can assist the current project, but its network-building element can also become an enabling condition for future innovation projects. These “outward functions” of teams must be particularly stressed by team leaders and members to counter premature perceptions of the adequacy of technical competency and material resources. Such perceptions of “self-sufficiency,” combined with a lack of appreciation for the utility of team-external competency and resources, are described by Janis (1995) as important preconditions to groupthink, leading to defective decision processes and consequently suboptimal task performance.

This is not to say, of course, that team members must pursue team-external networking for the sake of networking, but that team members should critically examine and question their competencies and resources to produce the desired output. This, in turn, may best be achieved through interaction with team-external contacts. Furthermore, managers should not interpret our results as a mandate to purposefully under staff teams or unduly limit resources such as space or funding in an effort to counter any network-numbing effects stemming from the team’s perception of adequate competency or material resources. To the contrary, management should design teams that include the best possible expertise along with adequate resources, while at the same time, as this study shows, ensure that these “all-star” teams are fully integrated into the organization and connected to their customers. Such integration and connectedness can be fostered through, for instance, focusing personnel and organizational development activities on the positive predictors of individuals’ network building as identified in this research. Team members and
leaders, particularly if placed on “all-star” teams, need to be trained and educated on the importance of knowledge networks to the sustained success of the organization.

Second, companies should foster a networking climate at the organizational level. Given the critical importance of networks and knowledge sharing from an innovation standpoint, it is important for the organization, through goal setting and other managerial practices, to stress the importance of building networks and supporting a networking-friendly environment where the members of the organization are willing to informally assist other members in accomplishing their tasks. For example, monetary rewards and performance appraisals can be tied to intergroup, not just intragroup, activities (Ancona & Caldwell, 1988). The findings from this research indicate the importance of norms and standards pertaining to the willingness to share knowledge and expertise within the organization. While systems and processes must be in place to guide individuals looking for contacts with a certain expertise or skill, those employees providing their knowledge to other colleagues should be recognized for such efforts. Organizational systems such as goal and reward structures may be reviewed in order to uncover and remove or minimize obstacles inhibiting cross-unit networking. A sense of cross-unit openness may be reinforced through such measures as joint social events or more formal organization-wide information sessions educating all members of the organization on other units’ objectives, competencies, and resources. Furthermore, openness and information sharing should be stressed as important elements in human resource practices regarding employee selection and training. Figure 1 lists examples of specific recommendations for managers that can encourage network building among their employees.

**Methodology, Limitations, and Outlook**

While this field study used a rigorous multi-informant cross-level research design and an appropriate cross-level analytical technique (HLM) on a large sample of individuals and teams, some limitations of this investigation are worth noting. This research was cross-sectional rather than longitudinal, which limits our ability to infer causality in the relationships investigated. Also, the data for this research were collected in Germany, raising questions of transferability of these results to other countries. The data from this research are not cross-national, and therefore cannot establish cross-national validity of the results. However, the underlying theoretical arguments as well as the nature of the industry (i.e., software development) are not country-specific, and we would expect our findings to replicate in team-based innovating organizations in other Western countries such as the United Kingdom or the United States. Having said that, we focused on cross-functional software development teams; therefore, future research on teams with other structures or purposes is needed to verify the generalizability of the results. In addition, we did not control for the age of the team (Katz, 1982) or differences in time pressure of the projects (Gersick, 1988), both variables that may potentially be linked to individuals’ network building. Since the teams in our study had relatively short lifecycles (mostly between four weeks and six months), we do not believe that inclusion of team age in our analysis would have substantively altered the findings regarding our hypothesized relationships. As for time pressure, interviews with
I. **Stress the short-term and long-term importance to the organization of individuals’ network building.**
   A. Provide training/awareness of the dangers of “groupthink.”
   B. Provide examples of successful “out-of-the-box” thinking.
   C. Encourage project teams to critically examine their knowledge, skills, and resources with regard to their project task.
   D. Encourage project teams to make every effort to be connected with the rest of the organization (and beyond if necessary).

II. **Create a strong organizational knowledge-sharing climate.**
   A. Make project-relevant information easily accessible.
      1. Establish and maintain relevant online directories and databases in a company intranet.
      2. Digitize printed information so that it can be accessed through a company intranet.
   B. Encourage individuals to build networks within the organization.
      1. Create cross-functional teams.
      2. Provide organization-wide information sessions emphasizing goals, needs, and resources of various departments.
      3. Organize social gatherings with different related organizational units.
      4. Hire individuals with established networks or a perceived potential of building them.
      5. Measure network development/activity as part of the individuals’ goal-setting/annual review process.
   C. Encourage individuals to provide assistance to others within the organization.
      1. Measure assistance to others as part of the individuals’ goal-setting/annual review process.
      2. Provide rewards (e.g., bonuses, recognition, extra vacation days, company logo merchandise, etc.) for demonstrated assistance to others.

This research has provided encouraging results as to the effects of team-level properties on the development of individuals’ knowledge networks in organizations. We hope that this study sparks increased research attention on the determinants of individuals’ networks, moving this field of research “backward” along the causal chain. Inquir about possible determinants of individuals’ network building in organizations can include factors on the individual, the team, the organizational, or the interorganizational levels, providing ample opportunity for future research. For example, while the team’s internal interactions (i.e., collaboration and exchanges within the team) are important to our reasoning for Hypothesis 4 regarding the influence of a team’s networking resources on individuals’ network building, we have not specifically included the teams’ internal interaction in our analyses. It would certainly be interesting to address possible relationships between a team’s internal interaction processes and its members’ ability to develop their individual knowledge networks. Similarly, future research may wish to add to team development intervention studies (Sundstrom et al., 1990) by investigating which managerial levers, for example, “ambassador activities” (Ancona & Caldwell, 1988) or “probing activities” (Ancona, 1990), are most effective in enhancing certain antecedents. The theoretical arguments, methodological
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considerations, and empirical findings presented in this article may serve as a starting point for further investigations. [Received: March 2002. Accepted: April 2003.]

REFERENCES


## APPENDIX

### Translations of the Measurement Scales

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
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<tbody>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
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<tr>
<td>Team’s perception of the strength of the organizational knowledge-sharing climate</td>
<td>(1) Project-relevant information was made accessible by the organization. (2) Colleagues from outside the team were willing to share their knowledge, information, and experiences. (3) It was easy to draw on existing knowledge inside the organization.</td>
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<tr>
<td>Team’s level of networking preference</td>
<td>(4) The team members were generally motivated to collaborate with experts from different disciplines and functions. (5) The team members were interested in working with people from other organizations.</td>
</tr>
<tr>
<td>Team’s perceived importance of networking for project success</td>
<td>To successfully complete the project it was important to: (6) acquire team-external knowledge, (7) coordinate team-external work contributions, and (8) seek feedback outside the team.</td>
</tr>
<tr>
<td>Team’s strength of networking resources</td>
<td>From the start of the project: (9) the team had relationships with team-external colleagues that helped the progress of the project, (10) the team had useful contacts outside our organization, (11) the team had enough contacts that could help out if problems arose.</td>
</tr>
<tr>
<td>Team’s perception of the adequacy of its technical competency</td>
<td>(12) The team had the necessary programming skills. (13) The team had the necessary knowledge regarding the application field of the software. (14) The team possessed the necessary knowledge regarding the software and hardware environment. (15) Through its composition, the team had, at all times, all the necessary know-how for this project.</td>
</tr>
<tr>
<td>Team’s perception of the adequacy of its material resources</td>
<td>(16) The team was given an adequate budget for this project. (17) Overall, the team was supplied with the necessary material resources.</td>
</tr>
<tr>
<td><strong>Dependent Variable</strong></td>
<td></td>
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<tr>
<td>Individuals’ extent of network building</td>
<td>Through this team project I have gotten to know people from other functional areas and divisions. I have acquired interesting contacts outside our organization through this project. This cross-functional project has increased the number of my personal contacts within our greater organization (including other companies within our group of companies). The project has allowed me to acquire more contacts than a line position would have.</td>
</tr>
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</table>
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