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Abstract

This paper reviews the literature related to virtual teams, knowledge sharing and communication. The literature concerning teams and their use of collaborative and knowledge management technologies is considered. A case study at Nortel, Inc. is discussed and findings are considered. The following eight categories of factors affecting communication and knowledge sharing were identified: 1) Leadership, 2) People, 3) Team culture, 4) Organizational support, 5) Social networks, 6) Knowledge sharing and communication, 7) Motivation and rewards and 8) Resources. The author addresses the issues of trust, collaboration, governance, communication, efficacy and performance and introduces these in terms of a process model. The Virtual Team Process Model is a framework for studying issues relating to team process in geographically dispersed groups. The model combines the moderators and resources found in the eight categories of factors affecting the virtual team process.

Keywords: Virtual teams, knowledge management, culture, communication, knowledge sharing, leadership, motivation, trust, social networks, collaborative

With the increasing speed of product and process life cycles (Iansiti & West, 1997), companies in the worldwide telecommunications and other high technology industries are driven by the need to disseminate and integrate knowledge into core competencies, core processes and core products in order to keep ahead of the competition (de Kluyver, 1999; Demsetz, 1991). Firms such as Nortel Inc. and other firms at the forefront of telecommunications are driven by the need to disseminate and integrate, reuse and create knowledge as a core competence. In order to keep pace with the competition, firms have been selecting more flexible and integrative organizational forms. Structures such as cross-domain and cross-functional teams allow firms to share knowledge from distributed knowledge bases in the creation of innovation in products, processes and services. Virtual teams are those that are primarily non-collocated. These teams communicate through a variety of collaborative and communication technologies in addition to some face to face interaction. Virtual teams allow individuals from dispersed geographic locations to work together, while minimizing travel and co-location expense and inconvenience.

This paper reviews the multi-disciplinary literature of virtual teams. The process of knowledge sharing and reuse by globally dispersed virtual teams within the firm is explored. In relation to these issues, of interest is the use or failure to use collaborative and other knowledge management technologies. Of special interest is the access to and reuse of knowledge through various knowledge modes including social relationships, interactive communication, knowledge management systems, and a variety of technological tools.

The study includes a brief survey of various problems and potential solutions for encouraging knowledge transformation and skill transfer between individuals and between teams. This treatise discusses a study of the virtual team process observed in one organizational unit, comprised of 40 virtual teams, at Nortel Inc. In the study, I develop a Virtual Team Process Model framework and then discuss how it applies to this team at Nortel. Nortel Networks teams operate in all areas of the organization. The organizational structure is extremely flat. Nortel's teams are truly global in nature. These teams work in a virtual environment where few members are co-located, keep in touch daily through the use of collaborative technologies (computerized white boards, teleconferencing, videoconferencing and email) and intranet-based databases. Structurally, the firm has enabled virtual relationships and communication for all team members as an integral part of their global strategy.

Multi-Disciplinary Literature Review

One of the biggest challenges in global firms will be to leverage their expertise through the transferring and reuse of skills and knowledge on a reciprocal basis across global boundaries (Bresman, Birkinshaw, & Nobel, 1999). This global transfer and innovation can be enhanced through the use of non-collocated or "virtual" teams. An IT infrastructure that is flexible and allows for increasing capabilities is an integral part of the structural change needed to meet this new environment of change. "Every enterprise can be viewed as an intermediary or a junction box that can create value through the use of …IT-intensive value innovation strategies." (El Sawy, Malhnotra, Gosain, & Young, 1999). Firms such as Nortel Inc. are particularly well positioned to take advantage of these opportunities. Due to the rich diversity of the firm's culture, with R & D facilities in 17 countries, they are able to understand and develop products and services that are suitable for the 150 countries and territories in which they do business (Nortel, 1999).

I divide the literature review into two sections, the literature of virtual teams and other lateral networks, and the literature of the moderators and resources available to these teams.

Virtual Teams and Other Lateral Networks

Cross-functional and cross-domain project and process-oriented teams (Frost, 1996; Galbraith, 1994; Jassawalla & Sashittal, 1999), designed to encourage coordination and innovation, have become an established part of the structure of most firms for both long and short term projects. As narrowly defined by Townsend and Marie, virtual teams are groups that are "geographically and/or organizationally dispersed coworkers that are assembled using a combination of telecommunications and information technologies to accomplish an organizational task". (Townsend & DeMarie, 1998, p.18). The dispersion may be moderate as in teams that are dispersed in several cities in close proximity, or it may be more extreme where teams are in several time zones scattered across the globe (Lipnack & Stamps, 1997; Miles & Snow, 1986) and may include those who rarely or never see or speak to one another (Knoll & Jarvenpaa, 1995; O'Hara-Devereaux & Johansen, 1994). The definition may be broadened to include members who are co-located. Here, teams use a combination of face-to-face interaction in addition to communication via telecommunications links and collaborative technologies (Duarte & Snyder, 1999).

Virtual teams may be within one domain or function or may be cross-domain (specialists from varied fields of expertise), cross-functional (specialists from several different functional groups) or inter-communal (representing a full range of specialist knowledge across domains and across functions). Virtual teams often require fluid membership for group problem solving and decision-making (Grant, 1995). The task may be temporary and/or adaptive to organizational and environmental change (Townsend et al., 1998, p.18).

Since virtual teams are inherently more complex due to time zones, location, and communication methods, they may encounter greater problems during coordination due to mobility and complexity of communication. Therefore, trust and leadership are two major issues confronting virtual teams that affect their dynamics (Katzenbach & Smith, 1999; Lipman-Blumen, 1999; Pfeffer, 1994). Team members must be able to trust the firm, and must be motivated and rewarded to encourage mentoring, documentation, and collaboration (Leonard-Barton & Deschamps, 1988; Szulanski, 2000).

Virtual teams may have problems beyond those of co-located teams due to dependence upon collaborative technology and the establishment of common ground (Grant, 1996; Majchrzak, Rice, Malhotra, King, & Ba, 2000). Although, the use of an emergent and malleable collaborative technology may lead to enhanced communication within the group (Majchrzak et al., 2000), issues of trust (Jarvenpaa, Knoll, & al, 1998), collaboration and leadership may be magnified due to communication and distance problems (Jassawalla et al., 1999) or governance issues (Duarte et al., 1999). Further, the organization may have constraints of time and financial resources that inhibit knowledge sharing and communication.

Moderators and Resources

Two types of factors, found in the cross-disciplinary literature on virtual teams, influence the success of the project process and the fulfillment of the project objectives. I use the term "moderators" for the first set of factors that I have grouped into seven (somewhat overlapping) categories. These factors "moderate" by either directly or indirectly affecting the performance of either individuals or teams or both. I use the term "resources" for the eighth category. These sets of factors include both people-based and electronic-based resources.

Leadership: Purpose, Values and Goals

Duarte and Tennant-Snyder (1999) discuss the critical competencies required for virtual team leaders including mentoring, coaching, technological skills, ability to encourage the use of technological tools, networking, building trust, cross-cultural management, career development and development of team process. Each team member will also need to develop certain skills to foster the team relationship. Team members often take up a leadership role at critical junctures in the project (Duarte et al., 1999), also known as "shared leadership". Establishment of purpose, values, goals and objectives, setting of policies and procedures and clear distribution of workload enable all team members to understand and work toward the same objective (Katzenbach et al., 1999; Lipman-Blumen, 1999). Senge (1990) stresses the fact that a true commitment to a "shared vision" will "bind people together around common identity and sense of destiny (Senge, 1990)."

People: Skills and Knowledge

The second moderator is the combination of skills, expertise, knowledge, diversity, and capabilities of the individual team members (Ghoshal & Bartlett, 1997; Pfeffer, 1994). Virtual teams allow firms to build a structurally flat organization with optimized team membership, selecting from the best people regardless of their geographic location. Access to previously unavailable expertise, enhanced learning, enhanced cross-cultural understanding, increased knowledge transfer, reuse and cross-functional/cross-domain interaction all add to the benefits for the firm (Townsend et al., 1998).

Team Culture: Trust and Collaboration

Team culture is highly influenced by the frequency of communication (Cyert & Goodman, 1997) as well as quality of communication. Integration is critical to the success of projects, and often results in a decrease in project completion time (Hoopes & Postrel, 1999). Integrated problem-solving is also critical for successful process development" (Pisano, 1994). Trust may be even more essential in virtual teams than in other types of teams due to the fact that the virtual-team context eliminates certain forms of social control such as direct supervision, face-to-face contact during meetings, and close proximity for monitoring work progress (Jarvenpaa et al., 1998). In new organizational structures traditional social controls based on authority are traded for governance based on self-direction and self-control (Miles & Snow, 1992). Trust, under this loose form of governance, promotes open and substantive information exchange, increases the influence of communication, improves confidence in the relationship (Earley, 1986; Yeager, 1978) and reduces transaction costs (Cummings & Bromiley, 1996; Handy, 1995). Concern has been voiced about communication without face-to-face meetings, for example, O'Hara, Devereaux et al claim that "Trust is the glue of the global workspace — and technology doesn't do much to create relationships" (O'Hara-Devereaux et al., 1994, pp 243-244). There has been some debate concerning the need for at least one face-to-face meeting to develop trust early in their formative stage. However, this early collocation may not always be possible.

Organizational Support

Creative teams of all types work better under conditions of ambiguity and are inherently non-hierarchical (Katzenbach et al., 1999; Lipman-Blumen, 1999). This is particularly so with the self-direction required by virtual team members. Systems that allow career path cross-development increase the ability of employees to see these core competencies in a new light.

> "Competence carriers should be regularly brought together from across the corporation to trade notes and ideas. The goal is to build a strong feeling of community among these people." (Prahalad, 1990)

Both formal and informal communication structures and teambuilding interventions that improve the ability of team members to transfer, capture, and combine tacit knowledge into new knowledge forms may be a source of sustained competitive advantage (Bresman et al., 1999; Sherman & Lacey, 1999). Knowledge hoarding, creating scarcity, is a cultural phenomenon that may be exacerbated by downsizing and fear of job loss. Meetings, open to all employees allow opportunities for sharing knowledge and new perspectives (Nonaka & Takeuchi, 1995).

Social Networks Theory

While strong ties between individuals (in working relationships and teams) encourage a depth of knowledge, weak ties can also be important in teams. Granovetter (1973) advanced the original weak-tie theory that suggests that distant and infrequent relationships (weak ties) are more efficient for knowledge sharing. These ties bridge previously unconnected groups, develop broader access to more organizations and are less likely to present redundant knowledge (Granovetter, 1973). Non-redundant knowledge includes both new information about existing inter-unit knowledge, and knowledge from outside organizations in

which the seeker has no direct ties. Direct contacts will act as bridges and can also provide their own specific knowledge (Hansen, 1999). Virtual teams will allow increased integration, greater flexibility and access to a wider social networks offering a variety of personal relationships and expert capabilities.

Knowledge Sharing, Reuse and Communication Skills

Creation of new knowledge and innovation is often dependent upon tapping the "tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole (Nonaka, 1991)." Knowledge transfer or sharing is the movement of knowledge from one source, the knowledge generator to a knowledge receiver or knowledge reuser either directly through personal contact or through an intermediary including other persons, environmental resource planning systems (ERPs), knowledge management (KM) systems, other systems, sources, collaborative tools, or meetings (Brown & Duguid, 1998). Knowledge reuse is adapting and synthesizing existing components, technologies, techniques, or procedures for use by a different person or group of people at a different time or location. Common ground can be defined as the beliefs and suppositions that the parties share about the joint activity or the set of shared norms and behaviors expected by others (Ouchi, 1980; Tsoukas, 1996). Different communities have different ideas of what is significant (Brown & Duguid, 1991). For example, Hewlett Packard found that what looks like a best practice in California may not turn out to be the best practice in Singapore (Cole, 1999).

Motivation and Rewards

Negative motivation can discourage knowledge transfer and reuse (Hayes & Clark, 1985; Katz & Allen, 1982; Zaltman, Duncan, & Holbek, 1973). Szulanski, (2000) notes, "Lack of motivation may result in procrastination, passivity, feigned acceptance, sabotage, or outright rejection in the implementation and use of new knowledge (Szulanski, 2000)". Effort and uncertainty are two major hurtles in locating distant knowledge. Simon and March use the term 'satisficing' to describe the human tendency to settle for the knowledge or information that is adequate, but not ideal, in order to make a decision or for the immediate purpose at hand (March & Simon, 1958). "Localness adds to market inefficiency because it causes people to make do with less than optimal knowledge while a much better 'product' goes unsold or unused. The values and norms of the group and the organization (Kostova, 1999) and the directives or incentives (Leonard-Barton et al., 1988) as well as the counseling and support of management (Attewell, 1992) will either inhibit or encourage knowledge transfer and reuse. The ability to exploit the knowledge transfer may be inhibited by the absorptive capacity of the receiver (Cohen & Levinthal, 1990). However, disincentives for reusing knowledge such as rewards for invention and not for reuse or cultural norms such as "not invented here" may also hinder absorption. The challenges of abandoning past practices in favor of new methods can be significant as shown in the innovation literature (Rogers, 1983), the planned organizational change literature (Glaser, Abelson, & Garrison, 1983) and organizational learning literature (Argote, 1999).

Resources: Collaborative Systems, Information Technology and Knowledge Management

The use of collaborative technology cyberspaces for shared resources, digital libraries, access to instrumentation and team communication, has provided a platform for knowledge sharing among virtual team members. Ross-Flanigan (1998) discusses the potential loss of trust due to lack of face-to-face interaction but suggests that the frequency and quality of virtual communication fosters rather than discourages interdisciplinary cooperation. The availability and ease of locating resources are a critical element of project success. Resources should also contain contextual information for ease of searching (Majchrzak, Neece, & Cooper, 2001a, 2001b). Face to face interaction has been augmented by a variety of technological tools. "Integration of various functional systems provides maximum value when application software is integrated…both within and between enterprises." (Kalakota & Whinston, 1997) Software should enable integration across varied hardware and operating system platforms. Systems can also be adapted to suit the team. For example, Majchrzak (2000) found that one virtual group changed their frequency of use incrementally adapting a collaborative tool to satisfy the group's needs (Majchrzak et al., 2000). Global access will be required to take full advantage of the resources available. Since one of the main problems with international communication is time and language based, the deployment of real-time audio & video for development and brainstorming should enhance interactive communication.

Methodology

This treatise discusses the first phase of a two-phase study of the virtual team process at Nortel, Inc. In Phase I, I conducted qualitative interviews and detailed case study of one large "team", the Talent Acquisition Team, comprised of 340 members in

the organization. In Phase II all members of this team were sent an online surveys. The group leader was surveyed separately with additional questions and her results will be triangulated with the results of team members. Phase II results will be analyzed and reported early 2003. Nortel's virtual team organizational structure is extremely flat, although functionally there exist some hierarchical reporting relationships. Some team members were collocated while others were dispersed geographically throughout North America (U.S. and Canada). The team used a combination of face-to-face interaction along with telecommunications and collaborative technologies, keeping in touch daily or weekly.

Nortel Inc. allowed access to the virtual team process including communication, knowledge sharing, motivation and knowledge reuse through the examination of the Talent Acquisition Team Each interviewee was involved in one or more tasks related to talent acquisition, including: university recruitment, Nortel internal and external job websites; internal recruitment; corporate recruiting including locating, interviewing, and/or hiring potential applicants. The Talent Acquisition Team sponsor provided a set of informants from varying levels of the organization and various locations in the U.S. and Canada, on a random basis. This method of selection can be problematic in that management could pre-select those individuals who shared a certain bias, or those individuals whose time was less important. However, the interviewer found that the informants were at varying levels including the team sponsor, the functional leader of the team, leaders of sub-teams and basic team members. All informants appeared to be very open during the questioning and some were openly critical of current processes. Therefore, it appeared that these pre-selection biases were not factors in the selection. Informants were contacted and interviewed by a single interviewer by telephone or face-to-face. The single interviewer prevented inter-rater reliability problems. Interviewees were diverse in terms of their tenure at Nortel, gender, job descriptions and their level of leadership in the firm.

The intent of the research was to identify factors that affected effective communication and knowledge sharing. The interviewer had a list of set questions. In addition an open-ended interview protocol was used to elicit further comments from each interviewee. This involved follow up questions relating to comments made by the participant. This protocol was piloted with an employee of Nortel Networks who was not a member of this team.   The protocol first defined virtual teams and knowledge sharing for the interviewee and discussed the reason for and focus of the interview. Questions included the formal and informal structure of the team, communication methods and frequency, motivation for team participation, incentives and disincentives, trust, collaboration, team environment, and the challenges of working on a virtual team. The participant was asked about the ways in which the team was most effective and least effective in reaching its goals and/or the goals of the firm. (Interview protocol is available on request). The interviewer fielded twenty interviews of sixteen participants, each lasting for one hour to two hours. These resulted in 102 pages of typed verbatim notes taken by the interviewer.

Notes from all interviews were organized by each question. The researcher assembled several tables to identify patterns across the interviews and coded these answers. While the researcher was familiar with the literature review discussed at the beginning of the paper, the intention here was to identify factors that were derived from the interview notes, rather than impose factors from the literature. This grounded theory assisted in identification of factors that affect the virtual team process. This methodology has been used successfully in the identification of factors that may not be apparent from previous research (Yin, 1994). By using this method, factors from the literature review were combined with new insights into the virtual team process from the interview results.

Results

Virtual Teams Process Model

From the literature and team member interviews, the researcher developed a framework for studying virtual teams, based upon the process of a team project. In this framework, we can examine the seven moderators of virtual team behavior and the use of resources by the virtual team. The Virtual Teams Process Model (Exhibit 1) is useful for studying diverse types of virtual teams, organized for either long-term or short-term projects. The teams may be involved in a variety of projects including product innovation, process innovation, functional departmental projects, operational issues, and strategic development or implementation. It is for this reason that we retain the "project process" in general terms of types of processes rather than an explicit stepwise progression. The project process has been addressed in a variety of contexts and industries and models have been developed for a variety of organizational forms that lead to theories of optimal project process. For example, Sanchez and Mahoney (1996) present a modular model of product design where coordination is embedded into "programmed innovation" in an attempt "to create the information structures of fully specified and standardized component interfaces in a modular product architecture (Sanchez & Mahoney, 1996)." Pisano (1994) explores the replication of new routines in projects designed to improve process development (Pisano, 1994). There is a need for a more general project process framework for firms to compare the process of

teams involved in a variety of activities within the organization. While many of the segments of this model may seem familiar, what is new is the combination of a multi-disciplinary approach to these model elements. They are important not only in an Information Science framework but also from the standpoint of organizational behavior, strategic management, organizational structure, productivity and innovation as well as other literatures. The model should provide understanding of the multi-disciplinary affects of various process elements, moderators and resources on team performance. The Virtual Teams Process Model (Exhibit 1) is such a framework.

There are three states in the model. The first state is the inception of the project or the team development, during which the project objectives are determined. This process may take place at varying levels of the organization depending upon the project purpose. In a product development process, the objectives may arise from customer requests or a perceived void in a product line. In some organizations, such as 3M, objectives may be introduced by anyone in the firm. In a government or commercially related bidding process the project may develop to answer an announcement of opportunity (AO) or request for proposal (RFP). In a functional team, such as the Talent Acquisition Team at Nortel, Inc. the purpose may arise from administrative or strategic objectives.

The second state includes the actual process elements carried out by the team. This state includes a loop back toward establishment of project objectives, as these may need to be re-addressed at any stage of the process. In addition, there is a feedback loop from the achievement of the objectives.

The final state is the fulfillment of the project objectives. This state also has a feedback loop during which qualitative and quantitative analysis of team success in the fulfillment of project objectives should be communicated and discussed between the organizational actors including managers, team leader(s) and team members. In addition, team members should review their team process in order to improve team function in the future. This review allows team process to improve.

Variance Model

Based on analysis of the interview data and the literature survey, the researcher was able to develop a variance model for the previously discussed moderators and resources (See Exhibit 2).

Moderators affect the entire virtual team process from the "project objectives" stage through the "fulfillment" stage. The resources of the organization that are available to the team come into play early in the process while determining project objectives and are important factors in team selection and all of the remaining elements of the project process. The following eight categories of factors affecting communication and knowledge sharing were identified: 1) Leadership, 2) People, 3) Team culture, 4) Organizational support, 5) Social networks, 6) Knowledge sharing and communication, 7) Motivation and rewards and 8) Resources. All of these factors affect team process in virtual as well as co-located teams. Virtual teams, however, may have stronger needs for enablement in regard to team culture, organizational support, social networks, knowledge sharing and communication, and resources, due to their distributed nature.

Participants in the in-depth interviews discussed the importance of these "moderators" and "resources". However, the researcher noted differences between individuals in different sub-teams. The following is a discussion of only a few of the participant comments regarding each of these issues.

Moderators and Resources

Leadership
Leadership issues include the establishment of purpose, communication of values, coordination and development of an enabling culture. The team sponsor discussed the team purpose,

> "The main mission of the group is to get the right talent in the company at the right time and put them in the right place. Each group has a talent plan, what employees will be leaving and what new people we need. (Decisions include) what vehicles we use to attract the talent, how do you get them interviewed, hired and embedded as a Nortel employee?"

The timing of the study was difficult for many team members. Several had just been told that there would be a new team sponsor of the Talent Acquisition Team and that the current team sponsor was moving to a new department. From the interviews, it was

apparent that this is not an anomaly at Nortel, Inc. Frequent job rotations are very common. Further, the team was undergoing a reorganization that had been in progress since June. While most interviewees seem to take leadership changes in stride, one participant discussed the disruptive nature of this particular change,

> "(The team sponsor) moving to another group was pretty shocking without any notice…(there are) a lot of changes going on and there is no communication."

People

Essential factors concerning people are developing or acquiring team members with the appropriate skills, expertise, and capabilities. It is also important to deal sensitively with diversity (age, gender, national origin, ethnicity, culture, location) and personality issues. Nortel Inc. uses the Talent Acquisition Team for finding qualified and creative employees, but the team itself also searches for their own qualified employees. Individuals found that the participatory nature and friendships with other people were important enablers. For example, one participant commented on his own capabilities,

> "Doing a job well, and feeling I contribute by maximizing quality and quantity of hires. Self-actualization, learning more as I am doing it. Competing with myself… a customer focused approach. Friendships are a big part."

The quality of work done by individuals from outsourced firms, was seen as a problem by several team members, for example,

> **"**The most frustrating (part of the work) is that once an offer is made, the drafting of the documents is done by another group and the mistakes that happened generated frustrations…a lot of time was spent putting out fires."

Several sub-team leaders and managers discussed challenges evinced by the flatter more virtual organization:

> "You are having to affect other people even though they do not report to you. But it requires even better relationship building skills."

Team Culture

Cultural issues such as encouraging trust, collaboration vs. competition, developing working relationships and team spirit all contribute to team effectiveness. The challenges of virtual teams was discussed by one team leader,

> "You have to work smarter to make a virtual team work well. If you take people working in different time zones and then you take some of the challenges and magnify these, time zones and cultural differences, you understand how challenging coordination is."

While Nortel supports a virtual team culture, project managers noted that some people are less capable of producing while off site. One project manager discussed this,

> "Most of the people are dependable and do a good job, but it takes a special person that can handle being on their own in another location."

There were individual differences in capabilities for collaboration rather than competitive behavior as was noted by the following comments by two participants in different sub-teams.

> "(One team member) looks at the other recruiters as being his competition. But the other folks are more collaborative. The folks I look at, as potential leaders are more collaborative…. (However) the majority of recruiters are highly competitive…When they come into this collaborative environment it is a complete shock."

> "People will discuss who can be trusted. (The) team was not perfect because of this. They (recruiters) are used to being paid on volume and commission and they are competitive and do not help each other out. That has had an impact on our team."

Organizational Support

The organization must provide special support for virtual teams. Team members who are in remote locations need to believe that they are fully supported and have equal opportunities. The firm must also provide adequate technological and physical infrastructure support for virtual functionality. Nortel, Inc. provides excellent strategic support for virtual teams and extensive access to electronic and telephonic means of interaction. The corporation has accepted telecommuting and remote intranet access by many employees. One project manager commented,

> "I feel strongly that virtual teams work and enjoy working for this company because it is accepted by the company. It is a definite advantage. It allows us to open up the diversity and incorporate other people rather than forcing them to show up on site every day."

The same project manager was also concerned about the tendency for the firm to outsource "non-core services" and to automatically lay off the "bottom 10%" of employees.

> "There is an inkling in the back of my head that some day I will be outsourced and laid off. It is fourth quarter and people are being laid off (in accordance with the) talent segmentation process, doing away with the bottom 10%. I agree with this but it is disheartening…"

A recent factor that will affect any face-to-face interaction has been a corporate-wide rule to limit all travel to essential business only. Some individuals were pleased with the limitation due to personal needs, however it is probable that some team relationships may suffer. While some people might find frequent job changes disconcerting, most of the interviewees found it exhilarating and challenging. For example, one participant discussed role changes.

> "Helping to develop others… (and) being able to negotiate and deal with difficult situations has helped me to change and grow. My role has changed 15 times, and I have been able to keep an open mind about evolving in different roles."

Social Networks

Team members should be selected for both depth of knowledge resources and contacts and breadth of knowledge resources and networks. Nowhere is this more evident and critical than in talent acquisition. Coff (1999) mentions that the development of extensive internal networks should enhance the firm's capabilities (Coff, 1999). The frequent job rotation at Nortel Inc. appears to create a greater number of weak ties in the organization. This certainly seems to be confirmed by the interviewees who often mentioned that Nortel hired many independent recruiters and that these individuals had a larger variety of contacts.

Knowledge Sharing

Knowledge sharing and communication skills are enabled through skill development, education and training. In addition the culture of sharing should be supported at all levels of the organization. In knowledge markets there are knowledge sellers (also known as the experts), and knowledge buyers. Three factors cause knowledge markets to operate inefficiently (Davenport & Prusak, 1998). One factor is the incompleteness of information and guides for both buyers and sellers, including explicit information about price structure. A project manager mentioned,

> "(One team member) was to divide up his workload, but for a month he had not shared his knowledge and workload with (a second team member)."

A second factor is the asymmetry of knowledge, abundant knowledge in one department and a shortage somewhere else. Knowledge feasts and famines have more to do with information patterns and distribution systems rather than absolute scarcity as discussed by the team sponsor,

> "There is not enough knowledge sharing…The fact that we are a virtual team (and are located) all over the world has its downside."

The third factor is the localness of knowledge. In fact, due to lack of trust, face-to-face interaction is often the best way to procure knowledge. Reliable information about more distant knowledge sources is often unavailable**.** A participant discussed this problem,

> "(Only about) fifty percent of the people share information with others. Maybe it is because they have never met face-to-face."

There are several pathologies, which explain non-optimal behavior regarding knowledge transfer. The first of this is a knowledge monopoly. The knowledge holder hoards knowledge due to awareness that, in the act of sharing, their monopoly will cease to exist. Among those interviewed, knowledge hoarding was rarely mentioned. In fact one team member mentioned, "I don't see anyone keeping resumes to themselves." Trade barriers in the knowledge market may be caused by unwillingness to accept knowledge from outside sources (not invented here). An organization may lack knowledge transfer infrastructure or effective market mechanisms including a time and place for to transfer knowledge. In addition, the quality of the information obtained from outside is also important. Not all information is factual, and all factual information may not be useful. One interviewee commented,

> "Some of the ideas some people have are not that good. So it would depend upon who told me the idea, or how much thought had gone into the idea that was presented to me."

Motivation

Organizations and teams should reward sharing, group rewards enable collaboration while pay for performance and individual rewards encourage hoarding and monopolies. Among the recruiters there seems to be an internal conflict between organizational motivation (extrinsic rewards) and psychic rewards (intrinsic motivation). One recruiter mentions both,

> "There is a contradiction between what was desirable and what was stated. This was regardless of the objective criteria. (Rewards are) both volume-based (and for) thinking outside the box and being customer driven. In spite of this, people want to be number one and have as many "hires" as possible. Some enjoy the adrenaline."

The problem stems from the basic corporate financial reward structure as the team sponsor concludes,

> "There is quite a bit of competition among the groups. The Nortel structure rewards individuals, not team efforts. I came in brand new…there was a lot of competition for them to prove themselves to me. We have these silos, since we reward the individual approach."

Resources

At Nortel, a combination of electronic, human, physical, and document-related resources are available to team members. These resources may contain data, information, explicit knowledge or tacit knowledge or a combination of any of these. Human resources quality and quantity seemed to vary from group to group. Keeping up with high quality personnel needs is difficult with the high growth planned by Nortel, Inc. Some individuals complained that there was insufficient manpower to drive the Talent Acquisition process,

> "Where you are hiring 10,000 people in one year, we may have had a lot of little leaks, but then you turn up the volume and you really see where the leaks are."

Other individuals were pleased with the available resources,

> "As far as the resources I have, I have expert contributors. I have someone who is assigned to me in talent marketing…someone in competitive intelligence…someone from talent acquisition. It's a pretty cool infrastructure. You have…everything you need in a recruiting organization. If you looked at all of the elements you need, we've pretty much got it."

In regard to electronic and telecommunications resources, extensive use of email and voice mail for interaction was found among all personnel, especially those who were not collocated. However, "email saturation" was a common complaint. Weekly teleconferencing was also popular, however, difficulty in getting everyone to join the call was cited as the biggest hurdle. Visual information is sent via email prior to the call to enhance communication. It was interesting that none of the interviewees mentioned collaborative technologies such as virtual white boards for real time visual access during discussions. These technologies can be used in "real time" or asynchronously and are more collaborative in nature than emails. Also, considering that this is a high technology firm, it was an interesting finding that videoconferences were seldom used and desktop video

capability is not provided. The team sponsor used monthly videoconferences with her direct reports. It seems that the problem may be the lack of facilities and/or quality of the technology. One manager mentioned quality,

> "I have participated in video conferences. It's not a refined technology. In fact, it can almost impede communication. If you get there and cannot connect, you have to improvise. I would not give it a glowing recommendation just yet."… "We don't make the video-conference systems, we make the infrastructure it travels on."

The lack of immediate response and visual impressions were two problems cited in relation to virtual communication. Travel for face-to-face meetings may assist remotely located employees in feeling more connected. One project manager in Canada noted that some off site group members felt that they were "out of the loop." Disenfranchisement of solitary home-based workers in remote locations was found to be a problem with certain team members at Nortel Inc. One manager commented, "We do have a new employee who wants to come up here every week from Orlando, Florida."

Conclusions and Implications

Organizations such as Nortel Networks are pushing to make virtual teams more ubiquitous. Their widespread use of virtual teams to share information laterally and to reuse information should increase their ability to innovate and attract the best talent. However, care must be taken to structure individual teams and the organization in such a way that teams will provide advantages rather than complications for the effective implementation of firm activities.   The Virtual Team Process model provided here should provide a framework for the study of firms, such as Nortel, during their development and implementation of a virtual team structure. The following eight moderators and resources affect the virtual team process:

- Leadership: establish purpose, communicate values, coordinate and enable autonomy.
- People: acquire and develop appropriate skills, expertise, and capabilities, encourage diversity and develop inter-personal capabilities.
- Team culture: encourage trust, collaboration, develop relationships, and imbue the team with spirit.
- Organizational support: support remote locations and provide adequate technological support.
- Social networks: select team members for depth of knowledge and breadth of knowledge resources
- Knowledge sharing and communication skills: enable skill development through education, training, and by providing resources and rewards structures for enabling these behaviors.
- Motivation and rewards: reward sharing, group rewards enable collaboration, avoid pay for performance and strictly individual rewards, target knowledge sharing in performance reviews.
- Resources: provide adequate quantity and quality of electronic, human, physical, and document-based resources, (including data, information, explicit and tacit knowledge).

Phase II of the study is in the data collection and analysis phase. Each member of the Talent Acquisition Team (approximately 340 members) was sent, via email by the team leader with a link to a web-based survey. Each team member was urged to respond and assured that the information would be collected by an independent researcher and would be confidential. All respondents assessed the effectiveness of their sub-team, and their own effectiveness and productivity using the Role Based Performance Scale (Welbourne, Johnson, & Erez, 1998). This scale looks at both role and extra-role activities providing a multi-dimensional view of team members' performance. Five different roles are covered: job, career, innovator, team member and organization citizen. The team leader also filled out an additional survey covering the productivity and successfulness of several of the 40 sub-teams. To date we have received an approximately 50% response rate and are still awaiting final tabulation of the data.

This study has been limited as it is a case study of only one firm and sub-teams involved in only one functional area of the firm. Further study is required into a variety of organizations, in other functional and operational areas and in various domains. During such study, we may find additional moderators of virtual team process or differences in how these moderators affect different types of firms or functions within firms. It is valuable, however, to consider this multi-dimensional and multi-disciplinary view of the virtual team process and to urge firms to consider these views during team development and organizational strategic planning. In the dynamic framework of change, the dissemination and utilization of knowledge will be the major driver of enhanced innovation and value creation.

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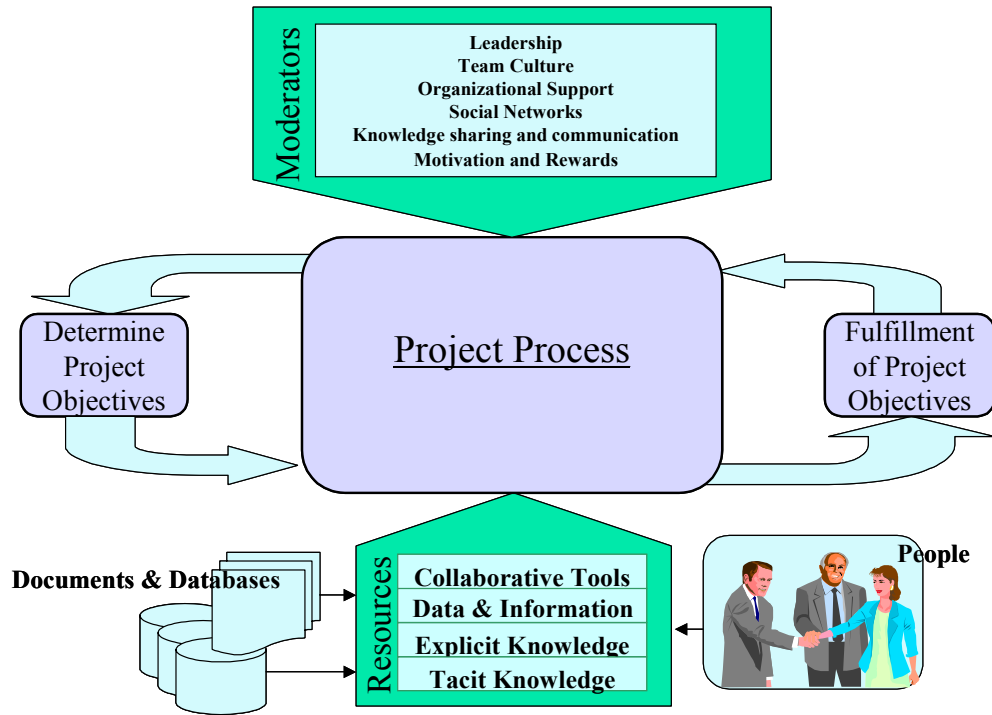Zaltman, G., Duncan, R., & Holbek, J. 1973. Innovations and organizations. New York: Wiley.
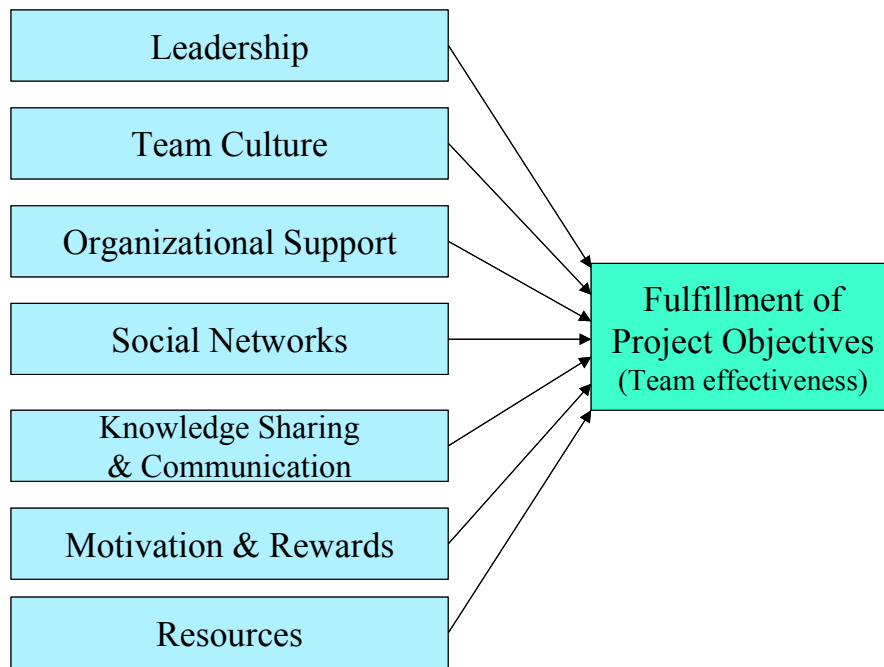
Exhibit 1: Virtual Teams Process Model

Exhibit 2: Virtual Team Variance Model