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Cross-functional Teams and Informal Social Networks: A Case Study of Project Development and Performance in a Multidisciplinary Science and Technology National Laboratory

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Abstract

The present study focuses on a single cross-functional project team in a multidisciplinary science and technology national laboratory in the United States, with particular emphasis on the contribution of team-member networks to project success. Semi-structured interviews were conducted with members of the subject team and with project stakeholders to identify how this factor, namely network-embeddedness, along with other organizational and individual variables, had an impact on team productivity and success. The study's findings indicate that, while there is growing emphasis on the use of cross-functional teams in this laboratory as elsewhere, customary institutional support mechanisms fail to sustain teamwork when they are not specifically aimed at the utilization of networks to generate knowledge and other resources. Management support for team networking, on the basis of conscious awareness of the importance of networks, determines the extent to which network engagement may influence group performance.

Introduction

Most of the work conducted in major scientific research laboratories now relies on teams rather than on the initiatives of lone individuals (Cohen, Kruse et al. 1982; Rosenthal 1997; Thamhain 2003). However, team-specific knowledge is, of itself, insufficient, and team members must develop and make use of informal peer networks to gather requisite information and resources (Stevenson 2000; Cross 2002). The interrelationship between teams and informal social networks has surfaced in the literature as an important dimension of organizational dynamics and a requirement for product innovation, corporate performance, and value creation (Tsai and Groshal 1998). While much has been published concerning private R&D organizations, very little is available on public or hybrid scientific research facilities such as the multidisciplinary national laboratories (Mote 2005). Hybrid research organizations are government-owned and privately-operated facilities with a blend of private and public institutional resources, and mixed cultures, in distinction from those of private R&D firms. The blending of entrepreneurial and public-bureaucratic cultures conditions the relationship between research teams and social networks.

The national laboratory here examined is one of several large multidisciplinary labs that provide a wide variety of services for the Department of Energy (DOE), ranging from what is known as *weapon surety* to renewable and fossil energy development. (It needs to remain anonymous as a condition for publication of the original research paper prepared by author Valdez and by extension the current, coauthored study.) These laboratories are not strictly organized along functional divisions; due to financial sponsorship from a variety of DOE programs, they operate in a matrix fashion (Mote 2005). In matrix organizations, functional specialization predominates even as cross-functional integration is employed for product or program development (Holland, Gaston et al. 2000). In addition to serving their primary program sponsors, national laboratories are authorized by the DOE to spend a percentage of their program funding on discretionary laboratory-directed research and development (LDRD) projects. The purpose of these projects is to enhance the given laboratory's scientific and technological capabilities in addressing future DOE missions, and to invest in high-risk, high-payoff research activities (ORNL 2005).

Typically, LDRD projects are short-term, lasting three years or less, and are very technically-oriented. Small teams with fewer than five members, drawn from the same functional area of the organization, typically lead such technological projects. LDRD projects are the focus of the present research because they provide compelling examples of how project teams come to rely upon informal, cross-functional, trans-disciplinary, and trans-organizational networks in project design and implementation.

In 2003, the directorates in the Energy, Security, & Defense Technologies Division in the subject national laboratory approved an Energy Systems Analysis LDRD (E-LDRD) that included a larger multidisciplinary team (10-12 people), on the premise that such a team could provide broader and more creative solutions to particularly challenging and ambiguous energy problems. Management's intention was to improve communications and to better integrate the division's various functional departments. Although other LDRD projects were starting to incorporate multidisciplinary teams, they did little to reduce team insularity. The scope and goals of the E-LDRD were more comprehensive that those of previous LDRDs in the division, and the intended purpose was to overcome prevailing obstacles to collaborative teamwork there.

The aim of the research here reported is to explore the various individual and organizational factors which project participants and stakeholders believed led to greater or lesser degrees of success for the E-LDRD project. Further, the case study aims to identify how and why these individual and organizational level antecedent factors affected the development and performance of the team gathered around the Systems E-LDRD project. The case also aims to identify and evaluate the role of informal networks in project success, and in particular that of knowledge networks. Consequently, the following questions arise:

1. To what degree does management support affect the performance of a CF-team?
2. To what extent does management affect the development and use of networks in projects?
3. To what extent do social networks affect the success of a multidisciplinary research team?

Review of Related Literature

During the nineteen fifties and sixties, research into team dynamics began to be related to research on networks. Studies conducted by Bavelas in 1950, Bavelas and Barrett in 1951, and Shaw in 1954 and 1964 applied network methods to the question of how communication patterns influenced team effectiveness (Sparrowe, Liden et al. 2001; Katz and Lazer 2003). These studies pointed to ways that the complexity of information demands affected a network, demonstrating that centralized communication was indicated for simple information but dysfunctional for complex information (Katz and Lazer 2003). However, this research eventually lost momentum and developed separately in the literature (Katz and Lazer 2003). Nevertheless, important correspondences and linkages between teams and networks have regained considerable prominence in organizational studies (O'Toole 1997; Mandell 1999; Stevenson 2000; Mandell 2001; Murray 2002; O'Toole 2004).

Teams both reflect and affect the organizations of which they are a part (Donnellon 1993). Current research into teams takes up numerous concerns, including the effects of individual actor traits on team performance, the impact of group processes as such, and relationships between teams and other parties (Rosenthal 1997; Gottlieb 2003). Some studies of team dynamics dwell on the interaction between organizations and team performance (Donnellon 1993; McDonough III 2000). According to the literature, cross-functional teams will make for greater success in efforts at new product development than other teams (McDonough III 2000). Potential benefits include a reduction of conflict between functional departments, the preemption of intra-organizational problems, and a harnessing of the potential energy of teamwork, which translate into greater efficacy in the product-development process (Donnellon 1993; Keller 2001; Barczak and McDonough 2003). However, some research suggests that cross-functional teams are not necessarily advantaged in these respects over other types of teams (Keller 2001).

A cross-functional team is more than a collection of individuals from different departments, divisions, or disciplines (Keller 2001; Bonner, Ruekert et al. 2002). A CF-team is marked by a high degree of interdependence among team members; by definition, it is employed for its ability to bridge functions and thereby deliver better performance (Holland, Gaston et al. 2000). Reagans and Zuckerman (2001) propose, in their study of the role of networks, tenure, and productivity in corporate R&D teams, that network density—the degree of functional articulation within and among team-member networks—has significant positive effects on productivity. Communications across network cohorts will best contribute to productivity when network linkages and interactions are relatively strong.

Several organizational and individual factors must be considered when assessing the performance of a cross-functional team, in particular those control mechanisms used by management to elicit desired norms and behavior. Project teams without the proper control can wander off-strategy, generate endless debate, run behind schedule, waste resources, and pursue concerns ill-suited for the strategic direction of the organization (Bonner, Ruekert et al. 2002). However, too much or the wrong type of formal control by management can constrain a team's creativity, impede its progress, and reduce its performance (McDonough III 2000; Bonner, Ruekert et al. 2002; Reilly, Chen et al. 2004). Studies by Gladstein (1984), Ancona and Caldwell (1992), West and Anderson (1996), McDonough (2003), Reilly and Chen et al. (2004), and Thamhain (2004) suggest that organizational climate, managerial support, empowerment, resources, and goals are basic organizational factors that impact the success of a project team.

Organizational climate is created consciously and unconsciously by management through its actions, policies, rewards, and incentives (McDonough III 2000; Farris 2002; Thamhain 2003). These factors are found to have the strongest effect on team performance if they satisfy the personal and professional needs of employees (McDonough III 2000; Thamhain 2003). With regard to management support, McDonough (2000) and Reilly and Chen et al. (2004) suggest that it can take a variety of forms having a direct impact on project performance. Managerial support includes demonstrating project commitment, assisting teams to surmount obstacles, and providing encouragement (McDonough III 2000; Pearce 2004; Reilly, Chen et al. 2004). Furthermore, managerial support can create an atmosphere of trust and collaboration, improve project ownership among team members, increase the clarity of project goals and vision, and reduce intragroup conflict (Barczak and Wilemon 2003; Reilly, Chen et al. 2004). However, a lack of managerial support can impede project performance correspondingly, and it can therefore increase the likelihood of failure (Hitt, Nixon et al. 1999; Barczak and Wilemon 2003).

In the literature, *empowerment* (a term almost debased by overuse) signifies the degree of freedom and authority that teams have to conduct project tasks, as well as team self-direction. It has been shown to speed product development, increase personal responsibility, and stimulate trust within organizations (McDonough 1991; Reilly, Chen et al. 2004). Studies by Kirkman and Rosen (1999), Holland and Gaston et al. (2000) and Reilly and Chen et al. (2004) found that it can increase commitment, cooperation, enthusiasm, and a sense of ownership among team members with regard to team mission and goals. However, these impacts vary depending on the level of discretionary authority allowed a team as well as the degree of uncertainty defining a project task. According to Reilly and Chen et al. (2004), highly uncertain projects require more empowerment than do projects marked by a higher degree of certainty.

Depending on their type and availability, resources constrain project performance. Constrained resources prompt different processes and patterns of communication among teams than do resources that are readily available (Ancona and Caldwell 1992). Research by McDonough (2000) found that human resources (such as individual skills and training) positively impact team performance, suggesting that project teams require an irreducible level of human resource endowments in order to function effectively. However, Ancona and Caldwell (1992) found no significant relationship between *financial* resources and project team performance, suggesting that otherwise-endowed project teams can still perform successfully when fiscal resource constraints obtain.

The final organizational factor, goals, serves two vital functions. First, through program charters and project plans, goals act as a control mechanism by specifying boundaries that prevent a team from continually reconsidering its direction (McDonough 2000). Secondly, goals serve as a process mechanism enabling team members to understand what they are trying to achieve (West and Anderson 1996). Research shows that established goals that are clear, consistent, and specific provide focus and motivate team members (West and Anderson 1996; Lynn and Reilly 2000).

Studies by Gladstein (1984), Ancona and Caldwell (1992), Keller (2001), McDonough (2003), and Reilly and Chen et al. (2003) have identified *individual* factors such as leadership, roles, tenure, functional diversity, and demographic characteristics as having a significant impact on team development and performance. Other studies have shown that leadership styles and team roles can either impede or promote team process and performance (Wageman 2001; O'Conner and McDermott 2004; Pearce 2004). For example, individuals playing the role of project champions may informally contribute to the success of a project by gaining support from key stakeholders, identifying and obtaining resources, and maneuvering the team through organizational barriers (Howell 1998; Markham and Griffin 1998; Howell and Shea 2001). However, Markham and Griffin (1998) also found that champions do not serve to improve team performance when teams are unwilling to support those champions' initiatives.

Functional diversity, diversity of skills, and tenure status are criteria that research suggests should be used in team selection (Barczak and Wilemon 2003). These criteria describe where people are located in an organization, the length and quality of their service, and the unique perspectives and capabilities they bring to a project. These instantiations of diversity bring a team multiple sources of information and knowledge, and they therefore bear directly and indirectly on team performance (Ancona and Caldwell 1992; McDonough III 2000; Keller 2001; Thamhain 2003).

Ancona and Caldwell (1992) found that functional and tenure diversity have a direct negative relationship with project performance when they adversely impact the intra-group processes of team-building and consensus-building. However, their research and Keller's (2001) follow-on studies also suggest that functional diversity has a positive indirect effect on team performance when it serves to expand access to external communications. Keller (2001) found that cross-functional teams are more likely to deliver better-quality technical results when they bring into play the complementary or co-specialized skills of external parties comprising team-member networks.

Taken together, these studies suggest that an interdependent and reciprocal relationship exists between these two types of factors. Individual factors not only influence a project team directly, but also indirectly through their influence on other individual and organizational performance variables. Similarly, Kirkman and Rosen (1999) found that organizational policies, rewards, and management support all impact leadership behavior and team empowerment.

Additionally, these studies suggest that the influence of various factors is contingent upon the type, structure, and degree of homogeneity or heterogeneity found in a team. Lastly, some studies suggest that the relationship of external communication to internal communication conditions the level of group cohesiveness for a team, so that the development and use of external networks may also—unwittingly—serve to diminish group cohesion as it does group insularity.

Networks and teams

Current research on networks includes topics such as the role of networks in public administration, their role in science and technology policy, their management in relation to organizational performance, and their relationship with social capital. (O'Toole 1997; Portes 1998; Mandell 1999; Stevenson 2000; Mandell 2001; Putnam 2001; McGuire 2002; Murray 2002; Barczak and McDonough 2003; O'Toole 2004; Rivera and Rogers 2004; Cross, Liedtka et al. 2005). Networks are required in order for organizational actors to informally exchange resources. To be accepted as a member of a network, one must possess something of value (i.e., resources, social capital) that other actors find beneficial.

At a basic level, a *network* is a connection of individuals or groups, such as teams or organizations (Newman 2003); these connections are joint structures that build on the affinity of clustered values and ideas with particular mixes of goals and tasks. *Networking* refers to the making of informal connections through the use of past collaborative relationships, relationships based on factors such as a shared university background, common professional specialization, and other forms of affiliation (Mandell 1999).

In the public sector, networks are the structures through which public goods and services are planned, designed, produced, and delivered (McGuire, 2002). Such networks are interdependent mechanisms that involve multiple organizations. They are fluid structures in which each unit becomes a part of others, rather than merely a superordinate or subordinate element in a hierarchal arrangement (O'Toole 1997;

O'Toole 2004). Networks may allow policymakers to seek innovative solutions that are beyond the reach of any one group or organization (Mandell 2001; Rivera and Rogers 2004).

In science and technology fields, networks are a critical resource through which scientists and engineers stay abreast of current disciplinary developments and share knowledge and expertise. Networks also allow the tracking of organizational plans and directives and project initiatives in science and technology settings. Murray (2002) found that most experts seek other experts in their field of study to expand their own specialized knowledge. The nature and quality of a knowledge network has a strong influence on the innovation process. That is so, for instance, when collaboration is driven by a combination of scientific challenges, the benefits of collegial work, and the exigencies of the peer review process (Murray 2002).

Various types of social and organizational networks are said to operate in these contexts. For instance, *advice* networks are created and used to share information, provide assistance, and give guidance instrumental to the completion of projects (Sparrowe, Liden et al. 2001). Conversely, *hindrance* networks are by definition taken to promote cynicism and undermine commitment to project goals, and they often make for lost resources and missed opportunities (Sparrowe, Liden et al. 2001).

Research into teams and networks has concerned itself with many topics, from social exchange and resource dependence to contingency theories (Rosenthal 1997; Nahapiet and Groshal 1998; Koka and Prescott 2002; McGuire 2002; Tidd and Bodley 2002). Contingency theories suggest that every organization is unique, and differently situated, so that variables that account for success in one organization or particular situation would not operate the same way elsewhere (Tidd and Bodley 2002). One cannot discount the enormous variability in organization-specific characteristics such as size, strategy, task structure, and culture. McGuire (2002) suggests that a network's contribution to team purposes is contingent upon the network's ability to be a significant resource in a given operational environment. An ill-fit between available network resources and the operational requirements of teams will raise the prospects for failure (Koka and Prescott 2002).

A network theory perspective brings several benefits to the study of teams. It offers insight into team dynamics insofar as teams are networked, and it offers techniques for identifying important features of small-group interaction. Network analysis (1) focuses on the relationship between actors, rather than the actors themselves; (2) assumes interdependence among actors; (3) considers the connections between any two actors to be covariant with still other network linkages; and (4), regards the boundaries among groups not as firm and static but as permeable and dynamic.

Katz and Lazer (2003) suggest that four developmental stages must be considered in order to fully appreciate the relationship between networks and team performance: networks predating team creation, those used during team formation, those employed during a given project, and those impacted by the project after the team is dissolved. The premise is that individuals about to join a team already belong to social and organizational networks which they can summon to their work in that team.

During team formation, the team leader makes use of informal networks to locate other potential members. Once located and recruited, these new members do not leave behind their own network relations but rather continue to gain access to and develop them in order to facilitate task accomplishment (Rosenthal 1997). The completion of a project and dissolution of a team will themselves affect extant networks—constricting them but also in some respects amplifying them, and setting the stage for future networks (Tsai and Groshal 1998; Rosenthal 1997; Hansen 1999; Sparrowe et al. 2001).

Reagans, Zuckerman et al. (2000) and Reagans and Zuckerman (2001) explored the effects of network embeddedness and member diversity on the selection and performance of cross-functional teams in a research and development organization. Their studies found that team-member selection based upon the density of network relations increased the team's access to social capital and led to better project performance than did member selection through functional diversity criteria such as skills, education, and tenure (Reagans, Zuckerman et al. 2000; Reagans and Zuckerman 2001). Reagans and Zuckerman (2001) further found that CF-teams with highly dense networks achieved higher levels of productivity than teams with sparse networks. These studies also indicate that teams and networks with greater heterogeneity were more productive, suggesting a correspondence between member variety and the number and types of network links, with the ideal being a team that is both diverse and well-networked.

Other studies conducted by Rosenthal (1997) and Sparrowe and Linden et al. (2001) have shown that network size, centrality, density, hierarchy, and type affect the performance of CF-teams. Sparrowe and Linden et al. (2001) examined the centrality and density of individuals' advice networks and hindrance networks in relation to individual and group performance. Although Sparrowe and Linden et al. (2001) found no relationship between network density and group performance, they demonstrated that centralization was positively related to group performance for simple tasks. As to hindrance networks, Sparrowe and Linden et al. (2001) found that they were negatively related to performance when they were allowed to encroach upon a team's work.

Rosenthal (1997) investigated how teams are constrained by network insularity, small network size (or number of network ties), and low network density (a low degree of interrelatedness). Rosenthal determined that, when so constrained, cross-functional teams perform relatively poorly. Moreover, he found that team members with stronger ties to their originating departments than to their team were less likely than others to share essential information and other network-accessible resources with the team.

Hansen (1999) expanded Rosenthal's research to include essential qualities of the projects investigated, such as task complexity and project duration. Hansen studied the role of network ties in relation to the performance of new product development teams, focusing on how team members used previously established inter-unit relations to transfer knowledge resources to the team. Although his findings (along with Burt's, 1992), were that weak ties provide greater access to nonredundant information, thereby leading to project success, Hansen concluded that weak ties were not beneficial in relation to redundancy because redundancy appeared in both strongly- and weakly-integrated team networks.

The primary benefit of weak ties was that they took less time to cultivate and maintain than strong ones, resulting in lower search costs for information and increased focus on project tasks. Although the maintenance of strong ties is more time consuming, Hansen found that strong ties provided the greatest benefit in situations entailing complex information. Putnam (2000) addressed the same questions from the standpoint of reciprocity and information-sharing.

The bridging of disparate networks depends upon individuals with the ability to connect with others critically located in other networks (Rivera 1998). This ability to bridge networks creates the opportunity to achieve a competitive advantage for individuals, teams, and organizations. The types of roles that can facilitate interaction with other networks are known as brokers, gatekeepers, or boundary spanners (Tushman and Katz 1980; Ancona and Caldwell 1992; Burt 1992; Rivera 1998; Burt 2000). They have proven to be a valuable resource in organizations where teams are dependent on timely and accurate information and the effective integration of complexly specialized knowledge (Tushman and Katz 1980; Ancona and Caldwell 1992).

Gatekeepers or boundary spanners are key individuals with high levels of communication access to other networks, often independently of their formal position or role in their organizations. These key individuals facilitate the performance of teams working in locally-defined tasks, by acting as a linking mechanism to (or brokering) external resources and information. Research by Ancona and Coldwell (1992) and Tushman and Katz (1980), found that project teams with their own brokers or spanners performed better than those seeking outside facilitators. Ancona and Coldwell (1992) found that when management imposed the spanning role on an individual who lacked the necessary skills, abilities, or contacts to carry it off, the team involved would perform poorly.

During the development of a team, managers and team members assess the resources, skill sets, and task structures required to complete a project; this assessment greatly influences the team's motivation to undertake corresponding network-building activities. When Hoegl and Parboteeah (2003) studied team-level factors such as knowledge-sharing organizational climate, networking preferences, and perceptions of task requirements, they found that managerial support increased the likelihood that a team would seek external assistance, through access to peer networks and other means. If discouraged, network-building was unlikely to occur. Regarding networking preferences, their research established that pre-existing networks bore little influence on new networks, but that, in general, team members who saw networking as important for project success were most prone to rely on network mobilization. By building networks, team members are able to gain access to (and transfer) information that is critical for innovation.

Hoegl, Weinkauf, and Gamuenden (2004) find that inter-team coordination in early to middle phases of complex innovation projects is most important in advancing projects, and that goal congruence, strategic alignment, mutuality, and trust across teams (and, by extension, across networks) will drive team effort and increase productivity. This finding is consistent with social network research, which suggests that social capital facilitates information flow and knowledge-sharing, strengthens group relations, and is positively related with team cohesion and productivity.

Methods and Findings

The methodological framework employed for the present research is an exploratory case study using a nonexperimental single-case design. Exploratory case studies are often used for heuristic purposes, to formulate new hypotheses, casual mechanisms, and variables. Particularly instructive are *outlier* cases where outcomes may be different from those suggested by prevalent theories in the literature. Single-case designs allow theory-testing related to most likely, least likely, or most crucial instances of the matter under study (George and Bennett 2005).

Accordingly, a single-case design was chosen, as an idiographic method that focuses on the qualitative, multi-aspect, and depth features of a singular situation involving individuals in groups (Larsson 1993). However, several limitations are inherent in exploratory case studies, which makes case-based results difficult to replicate for comparative analysis. Two of the primary data-collection methods for case studies, participant observation and interviews, are susceptible to interviewer, observation, instrumentation, and interpretation biases on the part of the researcher.

The methodological literature suggests that case studies selected on the basis of a dependent variable (project performance, in the present study) may understate the strength of the relationship between independent and dependent variables, and miss certain variables altogether. Nonetheless, single case studies selected on the basis of a dependent variable may lend themselves to the development or refinement of hypotheses, the identification of causal paths relating to particular factors of interest, and the testing of particular instances where there is significant variation in the dependent variable (George and Bennett 2005).

The present case study employed a small sample size, which may be expected in some instances to threaten the internal and external validity of the data collected. However, triangulation was used in the research study, in an effort to improve internal validity by strengthening the study design—in other words, the study resorted to multiple sources of data and data collection methods for the purpose of reducing threats to validity created by biases inherent in the single-case method (Patton 1990). The study sample was limited to a specific team with specific functional specialties in science and technology research. Coupled with the unique nature of the work conducted in the laboratory division under study, these are factors that tend to limit generalizability to similar research laboratories and R&D firms (Gottlieb 2006; McDonough III 2000; Barczak and Wilemon 2003; Thamhain 2003).

The study population consisted of 103 managers and 607 members of a technical staff with a total population of 710 people (N = 710) in the Lab's Energy, Security, & Technologies Division. Twenty-nine individuals were nonrandomly but purposively selected to participate in this study. Only 52% responded, creating a sample size of 15 people (s = 15). The selection criteria turned on an employee's involvement with the Energy Systems LDRD as a project team member or as a project team manager, i.e., as someone with a participant or stakeholder position invested in the outcome of the prospective project.

The functional areas of expertise represented were mechanical, industrial, and aerospace engineering, resource economics, physics, statistics, and computer modeling and simulation. About 81% of the respondents had Ph.D.'s, while 19% had a masters degree or less. Respondents had an average tenure of about 11 years at the lab, in a tenure range of 1.5 to 36 years.

Three data collection methods were used for this study: semi-structured interviews, historical and archival documents, and participant observation. Participant observation began three months after the LDRD project was initiated, and it was used to consider the organizational climate and the quality of individual interactions prevailing for participants in the LDRD project. The historical documents employed for this study consisted of program documentation, meeting and presentation notes, and other papers. Document review and participant observation were used as two prongs of a triangulation method capable of identifying common themes and of corroborating or contradicting interview data (as a third prong).

Two questionnaires were developed for the interview process based upon a participant's level of involvement with the LDRD project. Although most of the questions in both questionnaires elicit the same information, one questionnaire was directed toward management stakeholders, while the other was intended for employees directly involved with the LDRD project. The interview questionnaires consisted of both closed and open-ended questions, and 6-point Likert-scale questions with space for explanation (see appendix A for questionnaires).

Thirty questions were initially developed for each questionnaire, then pilot-tested. In a Delphi process, the two questionnaires along with the study proposal were sent to five reviewers familiar with the LDRD project for evaluation. This query was conducted twice, so that participants were made aware of their peers' first-cut responses, consistent with the Delphi method. Participants were sent the questionnaires via email and were given the options of responding personally in a direct interview, interviewing over the telephone, or answering in writing using electronic mail.

The scaled data thus collected were coded into Excel spreadsheets as interval data. The data were then analyzed using descriptive statistics, and frequency and cross-tabulation tables. Questions pertaining to tenure and education were coded in Excel as ordinal data, and the data obtained from the closed-ended "yes or no" questions were coded as nominal data. Demographic and closed-ended questions were analyzed using frequency and cross-tabulation tables.

Consistent with content-analysis methodology developed by Barczak and Wilemon (2003), the information obtained from open-ended questions was coded into text files and analyzed using a pattern-matching technique. This technique is a variation of content analysis and is commonly employed in exploratory case studies as a way to compare findings from a single case with those of the research literature (Berg 2001). A list of categories was identified, and then frequency counts were conducted based on thematic response patterns that were found in sequences of words and basic phrases. This procedure of quantifying responses in relative and absolute frequencies is common among case studies using content analysis (Barczak and Wilemon 2003).

A list of eight categories was developed for this study based on the organizational and individual factors identified in the literature review (Table 12.1, Appendix B). These categories served as the independent variables, with project performance as the key dependent variable. Each transcribed interview was reviewed to identify content themes and then compared and coded against a list of categories. Data were then re-sorted based on each interview question and reanalyzed to identify response similarities and differences. Observation notes and data from documentary reviews were also catalogued and coded against the aforementioned category list.

Table 1 presents the results of the content analysis of interview data; supporting findings for each factor are listed in Appendix B. This table includes a frequency count relating to the importance and use of informal social networks (ISN). Excluding these, the factor considered most important was managerial support (MGS 20%). Project goals (GLS 16%) and leadership (LDR 15%) were the second and third most frequently cited factors.

There was variance between team and manager respondents regarding the importance of organizational and individual factors. The top three factors identified by managers were managerial support (MGS

22%), leadership (LDR 18%), and team selection (TSL 10%). Two of these (LDR and TSL) were individual in nature. Among team members, the top factors were project goals (GLS 21%), managerial support (MGS 19%), and leadership (LDR 13%). Of these, the first two were organizational rather than individual factors, while leadership was understood as an individual trait-based variable.

Table 1: Cited factors impacting project performance and success

Factor	MGT	%	TEAM	%	TOTAL	%
ORC	8	8%	4	3%	12	5%
MGS	23	22%	28	19%	51	20%
EMP	2	2%	2	1%	4	2%
RES	1	1%	14	9%	15	6%
GLS	9	9%	31	21%	40	16%
LDR	19	18%	20	13%	39	15%
RLS	6	6%	5	3%	11	4%
TSL	10	10%	16	11%	26	10%
ISN	27	26%	29	19%	56	22%
TOTAL	105	100%	149	100%	254	100%

Project team success and individual performance were recoded on a scale of one (1) through six (6) into ordinal data with a scale of one (1) through three (3): 1-2 = 1; 3-4 = 2; 5-6 = 3; with one (1) meaning unsuccessful, two (2) meaning moderately successful, and three (3) meaning very successful. Table 2 indicates that the Energy Systems LDRD was not considered to be highly successful by a majority of participants (60% moderate, 27% unsuccessful). Only a fraction of respondents considered the team to be very successful (13%). Interestingly, none of the manager respondents saw the project as very successful (83% moderate; 17% unsuccessful), while most of the team-level respondents did not believe that the project was very successful (44% moderate; 33% unsuccessful)—one of a number of differences identified between the two respondent types. Team members were less positive about project outcomes than were managers, and in some respects their responses were more nuanced with respect to success.

Table 2: Team and management perception of project success

TQ24 & MQ11 Project Team Success	TEAM	%	MGT	%	Total	%
Unsuccessful	3	33%	1	17%	4	27%
Moderate	4	44%	5	83%	9	60%
Very Successful	2	22%		0%	2	13%
Grand Total	9	100%	6	100%	15	100%

Table 3 shows that most of the team-level respondents rated their individual performance as moderately (56%) to very successful (44%), while providing lower scores for the overall success of the project team. And, as indicated in Table 4, over half of the team-level respondents did not belong to a network before they joined the project team (56%), so that individual success may have turned on network participation.

Table 3: Team-level perceived personal performance

TQ16 Personal performance	(n=9)
Personal performance	Total
Moderate	56%
Very successful	44%
Grand Total	100%

Table 4: Existence of networks among team level participants

Team (n=9)	
Existing Networks	Total
N	56%
Y	44%
Grand Total	100%

According to Table 5, the use of informal social networks in pursuit of task accomplishment was considered very important by a majority of the managerial respondents (83%). Furthermore, most of these respondents (83%) made extensive use of their existing informal networks for work-related purposes. Regarding this LDRD in particular, most of the managerial respondents (83%) believed that the use of networks was a necessity for the project under study.

Table 5: Importance of networks, personal use, and perceived project necessity

MGT (n=6)				LDRD Project performance	
Network Importance	Total	Network Use	Total	Network Necessity	Total
Important	17%	Very Little	17%	N	17%
Very Important	83%	Extensively	83%	Y	83%
Grand Total	100%	Grand Total	100%	Grand Total	100%

Table 6 shows that managerial respondents who considered the use of informal networks important used their networks very extensively (100%) for work-related purposes. However, some respondents (20) who identified the use of informal networks as very important used their networks very little for work-related purposes. Interestingly, one respondent in particular who considered informal networks to be very important and used them extensively for work-related purposes did not consider their use to be necessary for the success of the project.

Table 6: The importance of networks versus extent of their actual use among managers

Network Importance Versus Use (n=6)	Network Use		
Network Importance	Very Little	Extensively	Grand Total
Important	0%	100%	100%
Very Important	20%	80%	100%
Grand Total	17%	83%	100%

In Table 7, just over half of the team-level participants (56%) engaged their existing networks while working on the Energy Systems LDRD—meaning that, conversely, nearly half did not, in some ways a surprising finding. However, most participants (89%) did make an effort to develop new networks.

Table 7: Team-level use and construction of networks

Network Use	Existing	New
Response (n=9)	Total	Total
N	44%	11%
Y	56%	89%
Grand Total	100%	100%

Table 8 shows that of those respondents who did not make use of their previous or existing networks, 25 percent also made no effort to develop new networks. This result may indicate the operation of a network-propensity factor, although specification of such a factor is beyond the scope of the present study.

Table 8: Team level use of existing networks versus new networks

Existing vs. New Networks	New Networks		
Existing Networks	N	Y	Grand Total
N	25%	75%	100%
Y	0%	100%	100%
Grand Total	11%	89%	100%

Results

Organizational Climate

Organizational climate, though not identified as a significant factor by respondents, seemed to the present researchers to act as a barrier to the success of the Energy Systems LDRD, and furthermore to impede the data collection process for this case study. The most apparent effects of climate were manifested through the laboratory's culture and in particular its system of sanctions and rewards. There was some apprehension at times—several potential participants declined to be interviewed because they feared that any negativity in their responses that might be traced to them could lead to some sort of reprisal by management. Oddly, one person actually declined participation for an altogether different reason, believing that the study—when released internally or published as a report—would not get the attention it deserved.

One of the stated strategic objectives of this laboratory is to become a "learning organization." In an ideal learning organization, risking failure is a key part of the learning process and therefore tolerated. However, this lab is somewhat risk-averse. It views failure negatively, and when failure occurs it tends to be attributed to individuals rather than the organization. Risk-aversion made for a lack of decisive leadership and for the shedding—"sub-tasking"—of group projects.

The lab's recruitment and hiring processes do little to attract prospects with good group and networking skills. Furthermore, the lab's reward system heavily stresses compensation for individual performance, which diminishes teamwork incentives, unduly promoting competition. Although individual skills and competitiveness can increase performance, and while team awards are occasionally given, the team dimension is seldom emphasized in the annual review process. That reality promotes an individualistic ethos. In an organization with a fixed budget allocated for pay raises, not everyone can be considered a top performer, and only a few are so recognized. While such decisions depend on deliberate efforts to peg compensation to performance, differential rewards are rarely given for team contributions. Cultural differences between the subject lab and private R&D firms are particularly evident in this regard, since the lab's actual use of competitive rewards seems to be inconsistent and counterproductive.

The functional matrix structure of this division, along with the reinforcing elements of culture and climate just cited, make for a lack of coordination and collaboration among departments. In fact, *stove-piping* is acknowledged to be a laboratory-wide malady. Some of the respondents who identified stove-piping as an issue could not say exactly how and why it occurred but agreed that it was an important concern, and that it impeded interdepartmental collaboration. Through observation and discussion with others outside the present study, it was found that most of the directorates in this division have distinct funding sources, and that managers are rated in large part based upon the amount of funding they bring to their administrative centers. There is little incentive for them to invest in bridging projects if these show little promise for financial return.

Management Support

Perceived low level of management support is the most significant organizational factor negatively impacting the LDRD team, a finding that closely tracks the results of research by Barczak and Wilemon (2004). Team-level respondents attributed lack of managerial support to various factors. Respondents felt that there was a lack of priority-setting, guidance, and oversight among managers and directors. Consistent with this view, most manager-respondents did not consider this project a high priority, largely due to the demands of competing projects. Most of the managers interviewed merely provided financial resources or staff. Only a few were directly involved in developing, managing, or promoting the project. Some respondents felt that management involvement was at times insufficient and sometimes excessive, and that it sometimes occurred too late to be of any tangible benefit. Lack of managerial involvement was taken to signal low project importance, a perception affecting team member motivation and commitment.

Based upon interview findings and direct observation, it is concluded that there was a misalignment of authority and responsibility in the present case—to the point that in one instance the project leader was not consulted when team members were reassigned by their respective line managers. The same project leader was held responsible by lab management for setting project direction while not really given the authority necessary to maintain accountability. Management's failure to assign him sufficient authority meant that he was forced to rely on what apparently was a natural ability to motivate others, as the only way for him to consistently motivate team members.

The amount of financial or human resources provided was not considered a significant factor determining the success of this project. These results recall the research findings of Ancona and Caldwell (1992) and McDonough (2000). However, team-level respondents identified some resource constraints that they felt were important to the project. First, this project lacked adequate human resources because some of the team members were not considered to be the right people for the project. Second, the needs of the project were not clearly identified. Third, some participants suggested that the level of funding did not match the magnitude of effort desired by management. For instance, some participants reported that management wanted as an outcome what they colloquially called the "mother of all models," which they knew from previous modeling efforts represented an unattainable optimum. Lastly, some regarded the time available to the project as grossly insufficient.

Goals

Tables 13.1 through 16 in Appendix B highlight several issues that indicate why project goals were the second most frequently cited factor impacting the success of the systems analysis project. Although there was a general agreement concerning the purpose of the project (Table 13.2, Appendix B), a majority of project participants and stakeholders could not come to a consensus regarding a specific outcome or even direction for the project. Such planning had not been finalized even when project documentation was approved. Moreover, project documentation was never modified to define deliverables more clearly. For instance, some directors wanted a detailed model in relation to a specific technology or energy source, while others wanted a more general meta-model that could assess different energy resources.

Although some ambiguity may have been intentionally introduced so as to give the team some latitude, it actually led to inter-departmental conflict and flagging commitment at all levels, for the duration of the project. The most common complaints were a general lack of focus, unclear goals, and indefinite objectives (Tables 15 and 16). Furthermore, the project team spent a significant amount of time refocusing and reselling the project due to issues relating to management support and team selection. Finally, it was felt that the team did not follow the defining documentation developed to guide the project. Although they believed that the project had significant results, most of the managers interviewed also reckoned that project outcomes were not in line with the goals defined in the project's documentation.

Leadership and Other Roles

The identification of leadership as the most significant individual factor contributing to project success supports the findings of McDonough (2000), namely that individuals fulfilling various leadership roles can act as facilitators for team success. However, leadership was here identified as a negative factor in this regard. At the managerial level, most individuals who held a stakeholder position did not take the initiative needed to assist the team when they believed that the project was floundering. Some of the managers who did attempt to help the team acknowledged that their assistance was often insufficient or came too late. At the team level, the project lead seemed to lack the necessary group-process skills to build the a sufficiently cohesive team.

Furthermore, the management style of the project lead appeared to be less than conducive to goal consensus and productivity. Although the lead had the technical skills necessary for the project, some believed that he lacked focus and failed to control project implementation (Table 18). Moreover, there were indications that some team members similarly lacked group skills and demonstrated a lack of leadership. For instance, some respondents recognized that they could have tried to be more assertive when they felt that their individual efforts were not effectively utilized. Finally, however, some of the study participants suggested that leadership did improve markedly when some incumbents changed (Table 18), i.e., that new project leadership was more responsive to the team and its stakeholders.

Participants did not identify roles as a significant factor attributing to the success of the Energy Systems LDRD. However, there were some issues in which role identification negatively impacted the project team due to a lack of goal consensus or to conflicting agendas. Several roles were identified by participants that pertained to technical skill, job function, or interest (Table 19). Of these roles, some were not conducive to the functioning of a high-performance team. For instance, one participant indicated that his role was to represent the interests of his home department, and he therefore pursued interests that were not specifically agreed upon by the team. Another participant could not identify his role in the project because he did not clearly understand how his work related to the end product.

These results suggest that roles were not clearly defined when the project was developed, and that team composition was not appropriate for the project. While team members eventually came to identify with productive roles in the project, these roles might better have been developed earlier. However, this was not done because the majority of participants reportedly failed to clearly understand project expectations (Table 13.2, Appendix B).

Team Selection

Team selection was considered the fourth most important factor affecting the project. The most important attribute relating to this factor was identified as technical skills or abilities. Functional diversity, demographic characteristics, and tenure were not considered by respondents to have a significant impact on team performance. However, some respondents thought that the size of the team was too large to be effectively managed, suggesting that teams should start small (around three or four key people) and then expand if needed, but no more than seven or eight members. These findings support Wageman's (2001) dictum that a team should not be larger than the minimum number required to accomplish the task, and that the optimal size is between four to seven people. However, other respondents felt that the development of a more permanent *community of practice* in systems modeling and analysis would require the use of larger teams.

With regard to attributes that served as team selection criteria (Table 20.3, Appendix B), several respondents suggested that some were established organizational features that adversely affected the team. The first such attribute was a management selection method identified as 'coverage' and the second was 'revolving door staffing.' *Coverage* here refers to department managers keeping idle employees involved in a project so that their time is not charged to overhead or their positions terminated due to lack of work.

Coverage can negatively impact project performance because individuals selected for a team based on this criterion do not necessarily have the right skills and abilities to satisfy the needs of a project. Respondents suggested that top-performing employees were always busy with high-priority projects, while lowest-priority projects drew lesser performers. The latter were often newly-hired or reassigned employees with unproven skills.

Those new arrivals who did prove themselves were likely to be 'pulled' from a project to work on higher-priority initiatives in their originating departments. This kind of turnover constitutes what some respondents called 'revolving-door staffing,' which is costly in several respects. For one, it requires constant orientation of new members. It is also the case that those coming to the team knowing it to be a temporary assignment are unlikely to commit to either team or project.

Social Networks

Following the previously-cited work of Katz & Lazer (2003), the researchers explored four steps in the developmental relationship between informal social networks and teams. These steps pertain to networks (1) that existed before the formation of the team, that take form (2) during team selection and development and (3) during project implementation, and that remain (4) after the project's conclusion and the team's dissolution. These steps or stages correspond to four questions: (1) Were the team members engaged with pre-existing networks applicable to the project; (2) were these networks used; (3) otherwise, were new networks constructed; and (4) were these maintained after the project ended? As it happened, just over half of the team-level participants in the Energy Systems LDRD reported no preexisting social network applicable to the project, and a significant number either considered networking unnecessary or simply did not invest in using social networks. One respondent believed that internal team supports were sufficient, while another volunteered that networks were unnecessary because "the team had all the skills and abilities necessary to perform." However, some did suggest that the team represented a good opportunity to build new networks. Attitudes toward networks corresponded to perceptions of project task requirements, consistent with Hoegl and Parboteeah (2003).

At the end of the project, when the team dissolved, participants who believed that the project was relatively unsuccessful had little or no desire to continue in any follow-on projects with other team members. This finding supports Katz and Lazer's (2003) assertion that maintaining new or existing networks at the end of a project is influenced by the level of success attained. In the present case, on balance, upper management provided insufficient support to the development of networks or to bridging efforts across and beyond the organization. Such activities were not sufficiently appreciated as critical to project success, or as efforts that should be taken up by management at all; ironically, as previously reported, manager-respondents were somewhat more likely to profess a high valuation of networks than were the team's members.

Project Success and Performance

Overall, some elements of the Energy Systems LDRD were considered successful while others were not. This project was deemed less than successful to the extent that it was seen to be ill-defined from the outset, as well as lacking in shared vision. Several stakeholders and participants believed that project outcomes fell short of specifications in project documentation. In many respects, because of this drift, many team members did not in fact see themselves as being part of a team that functioned successfully.

However, the project was a considered a success to the extent that it represented a number of learning opportunities and initiatives for the division. Some managers came to recognize the difficulty of working cross-departmentally, and they were able to develop a baseline assessment of the division's cross-functional energy systems capabilities. There were also some concrete gains attained:

1. The project provided the basic building blocks for a unified energy strategy currently under development, one that includes an energy surety approach that uses synthetic fuels as a method for creating a closed-energy system involving capture of carbon dioxide.
2. A multi-attribute evaluation model was in fact developed, serving as a programmatic resource for the comparison of energy options based on metrics other than costs. This is a model that is suited to participatory efforts consistent with stakeholder education and consultation.
3. The project led to several probing research reports that discussed innovative concepts, theories, and metrics.
4. Finally, several participants believed that involvement in the project fostered closer working relationships with others in the division and with other parts of the laboratory.

Conclusion

The organizational and individual factors described in the present study constitute patterns of complex interaction that have significant bearing on the success of cross-functional teams. Generally, the organizational factors here identified are managerial mechanisms that lie outside the direct control of teams, while individual factors are behavioral in nature and therefore particularly amenable to team-member control. When a project is successful, managers tend to attribute success to organizational factors such as clear goals and objectives, sufficient resources, and appropriate support. However, when a project is less than successful, they mostly fault individual variables, such as a lack of skill or poor team leadership. Conversely, team members typically attribute successful projects to individual variables, while attributing unsuccessful projects to organizational factors. In sum, managers and employees each tend to take credit for success and blame the other for failure.

The present study suggests that managers must exhibit a team orientation before they can expect that staff embrace teamwork. Management needs to clearly articulate and to demonstrate the benefits of teamwork. Teaming needs to be understood as more than just a necessary task: It involves a collaborative frame of mind, and mutuality and interdependence among team members. Management must grant teams a level of autonomy and discretionary authority that enables them to exert a good measure of control over organizational factors conditioning success.

Authority structures and distributions fall on a continuum between centralized and decentralized control, the optimal mix (and sequencing) of which depends upon the particular organization and its circumstances. The extent to which managers are willing to yield power to cross-functional teams is often determined by the leadership capabilities they see demonstrated by team members. Concordance between managers and team members in this respect is crucial for the successful development of autonomous, self-directed, high-performance, cross-functional teams.

Success in the creation of a cross-functional team does not necessarily translate into teamwork or collaboration, particularly if the organization fails to consistently and sufficiently support the teaming process. Managers must be willing to engage the institutional mechanisms that accommodate high-performing teams, working to generate the necessary resources (from operational resources to reward mechanisms), as well as undertaking and maintaining commitments that are essential to project implementation. Moreover, managers must be risk-takers if they are to be leaders, and they need to embrace rather than shun the possibility of failure. This they can do by allowing team leaders and members a sufficient share of decisional discretion. As it is, teams are seen—in the literature and in practice—to have progressively taken up more and more responsibilities and prerogatives traditionally identified with management. Therefore, giving them more discretionary authority is consistent with trends that now define self-directed teams.

In order to find the right people, managers need to attract and hire individuals with the right mix of technical and social or group skills, and to train and mentor them accordingly. However, these sets of skills and abilities must first be developed at management levels, so that the same managers can have a clear understanding of what it is they wish to promote (Gottlieb 2003).

The relationship between networks and teams is reciprocal in nature (Hansen 1999). Networks affect the dynamics of teams, notably in the identification or generation of internal and external resources, in information-sharing, and in knowledge-generation. Generally speaking, networks render teams more open systems, as does the cross-functional organization of work.

A defining purpose of cross-functional teams is to integrate separate functions or separate functional departments and to bridge otherwise disconnected resources, so as to acquire and combine project resources more effectively than could be done otherwise (Katz and Lazer 2003). Networking also expands access to critical information and knowledge. However, a concertation of effort between managers and teams is required to harness the power of networks and cross-functional collaboration to innovative projects. A shared commitment on the part of managers and teams to functionally-diverse and networked operations is critical to complex innovation in science and technology contexts.

The present study uncovered systemic problems in the organization and management of a project conducted by a highly specialized cross-functional team of scientists and engineers. It was found that the project was seen to produce significant results notwithstanding these persistent problems. It may be suggested, consistent with the study's findings, that what project success there was turned on complementarities that obtained between networking and team development. Survey, interview, and observational results from the study also suggest that there was synergy between (1) incorporated network resources and (2) complementary forms of expertise drawn from different functional departments.

Future research might examine more closely the interaction between networking and cross-functional collaboration in team-led projects, particularly, though not solely, projects aimed at multidisciplinary innovation in science and technology. What sets such projects apart is the exceedingly demanding challenge of taking scientific and technical innovation to entirely new levels, beyond the capability horizons of current technologies. Pushing the limits of knowledge to such an extent requires that diverse groups of highly-skilled individuals find ways to integrate and channel their efforts effectively.

Network utilization and cross-functional collaboration have become critical to the complex information-acquisition and knowledge-generation endeavors that scientific and technical innovation entails. The present study suggests that the deliberate and positive valuation of networks, along with concerted support for network creation and utilization, are crucial factors in this regard.

References

Ancona, D. and D. Caldwell (1992). "Bridging the Boundary: External Activity and Performance in Organizational Teams." *Administrative Science Quarterly* 37(4): 634-665.

Ancona, D. G. and D. W. Caldwell (1992). "Demography and Design : Predictors of New Product Team Performance." *Organizational Science* 3(3, Focused Issue: Management of Technology): 321-241.

Barczak, G. and E. F. McDonough (2003). "The role of trust and project commitment in new product development teams." Portland International Conference on Management of Engineering and Technology (PICMET 03), Portland, Oregon.

Barczak, G. and D. Wilemon (2003). "Team member experiences in new product development: views from the trenches." *R & D Management* 33(5).

Berg, B. L. (2001). *Qualitative Research Methods For the Social Sciences*, Allyn and Bacon.

Bonner, J. M., R. W. Ruekert, et al. (2002). "Upper management control of new product development projects and project performance." *The Journal of Product Innovation Management* 19: 233-245.

Burt, R. (1992). *Structural Holes: The Social Structure of Competition*. Harvard University Press., Cambridge, Massachusetts:.

Burt, R. S. (2000). *The Network Structure of Social Capital*, University of Chicago and Institute Europeen d'Administration (INSEAD).

Cohen, B. P., R. J. Kruse, et al. (1982). "The Social Structure of Scientific Research Teams." *Pacific Sociological Review* 25(2): 206-232.

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

Cross, R. (2002). "Six Myths About Informal Networks--and How To Overcome Them." *MIT Sloan Management Review* 43(3): 67-75.

Cross, R., J. Liedtka, et al. (2005). "A Practical Guide to Social Networks." *Harvard Business Review*: 124-132.

Donnellon, A. (1993). "Cross-functional Teams In Product Development--Accommodating The Structure To The Process." *Journal of Product Innovation Management* 10(5): 377-392.

Farris, G. F. (2002). "Leading Your Scientists and Engineers 2002." *Research Technology Management* 45(6): 13-25.

George, A. L. and A. Bennett (2005). *Case Studies and Theory Development in the Social Sciences*. Cambridge, Massachusetts, John F. Kennedy School of Government, Harvard University.

Gladstein, D. L. (1984). "Groups in Context; A Model of Task Group Effectiveness." *Administrative Science Quarterly* 29(444-517).

Gottlieb, M. R. (2003). *Managing Group Process*. Westport, CT, Praeger Publishers.

Gottlieb, M. R. (2006). "Group Dynamics and Behavior." M. Valdez. Albuquerque: Email communication.

Hansen, M. T. (1999). "The search-transfer problem: the role of weak ties in sharing knowledge across organization subunits." *Administrative Science Quarterly* 44(1): 82-111.
Hitt, M. A., R. D. Nixon, et al. (1999). "Corporate Entrepreneurship and Cross-Functional Fertilization: Activation, Process and Disintegration of a New Product Design Team." *Entrepreneurship: Theory and Practice*, Spring v23(i3): p145.
Hoegl, M., K. P. Parboteeah, et al. (2003). "Team-Level Antecedents of Individuals' Knowledge Networks." *Decision Sciences* 34(4): 741-770.
Hoegl, M., K. Weinkauf, and H.G. Gemuenden (2004). “Interteam Coordination, Project Commitment, and Teamwork in Multiteam R&D Projects: A Longitudinal Study.” *Organization Science* 15(1): 38-55.
Hoffman, J. J., M. L. Hoelscher, et al. (2005). "Social capital, knowledge management, and sustained superior performance." *Journal of Knowledge Management* 9(3): 93-100.
Holland, S., K. Gaston, et al. (2000). "Critical success factors for cross-functional teamwork in product development." *International Journal of Management Reviews* 2(3).
Howell JM, S. C., Higgins CA. (1998). Champions of product innovations: defining, developing and validating a measure of champion strength. *Best Paper Proceedings of the Academy of Management Annual Meeting*. San Diego.
Howell, J. M. and C. M. Shea (2001). "Individual differences, environmental scanning, innovation framing, and champion behavior: key predictors of project performance." *The Journal of Product Innovation Management* 18: 15-27.
Katz, N. and D. Lazer (2003). Building Effective Intraorganizational Networks: The Role of Teams. *Working Papers*, Center for Public Leadership.
Keller, R. T. (2001). "Cross-Functional Project Groups in Research and New Product Development, Diversity, Communications, Job Stress, and Outcomes." *Academy of Management Journal* 44(3): 547-555.
Koka, B. R. and J. E. Prescott (2002). "Strategic alliances as social capital: A multidimensional view." *Strategic Management Journal* 23(9): 795-816.
Kratzer, R. J., T. A. J. Leenders, et al. (2005). "Informal contacts and performance in innovation teams." *International Journal of Manpower* 26(6): 513-528.
Larsson, R. (1993). "Case Survey Methodology: Qualitative Analysis of Patterns Across Case Studies." *The Academy of Management Journal* 36(6): 1515-1546.
Lynn, G. S. and R. R. Reilly (2000). "Measuring team performance." *Research Technology Management* 43(2): 48-56.
Mandell, M. P. (1999). "Community collaborations: working through network structures." *Policy Studies Review* 16(1): 42-64.
Mandell, M. P. (2001). "Collaboration through network structures for community building efforts." *National Civic Review* 90(3): 279-87.
Markham, S. and A. Griffin (1998). "The breakfast of champions: associations
between champions and product development environments, practices
and performance. ." *Journal of Product Innovation Management* 15: 490 –504.
McDonough, E. F., III, and Barczak, G. (1991). "Speeding up new product development: The effects of leadership style and source of technology." *Journal of Product Innovation Management* 8: 203–211.
McDonough III, E. F. (2000). "Investigation of Factors Contributing to the Success of Cross-Functional Teams." *Journal of Product Innovation Management* 17: 221-235.
McGuire, M. (2002). "Managing Networks: Propositions on What Managers Do and Why They Do It." *Public Administration Review*: 599-609.
Mote, J. E. (2005). "R&D ecology: using 2-mode network analysis to explore complexity in R&D environments." *Journal of Engineering Technology Management* 22.
Murray, F. (2002). "Innovation as co-evolution of scientific and technological networks: exploring tissue engineering." *Research Policy* 31(6): 1389-1493.
Nahapiet, J. and S. Groshal (1998). "Social Capital, Intellectual Capital, and the Organizational Advantage." *The Academy of Management Review* 23(2): 242-266.
Newman, M. E. J. (2003). "The structure and function of complex networks." *SIAM Review* 45(2): 167-256.
O'Conner, G. C. and C. M. McDermott (2004). "The human side of radical innovation." *Journal of Engineering Technology Management* 21: 11-30.

ORNL (2005). *Laboratory Directed Research and Development Program: FY 2004 Annual Report*, Oak Ridge National Laboratory, US Department of Energy.
O'Toole, L. J., Jr. (1997). "Treating networks seriously: practical and research-based agendas in public administration." *Public Administration Review*: 45-52.
O'Toole, L. J., Jr. (2004). "Desperately Seeking Selznick: Cooptation and the Dark Side of Public Management in Networks." *Public Administration Review*: 681-93.
Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*, Sage Publications, Inc.
Pearce, C. L. (2004). "Citizenship Behavior at the Team Level of Analysis: The Effects of Team Leadership, Team Commitment, Perceived Team Support, and Team Size." *The Journal of Social Psychology* 144(3): 293-310.
Portes, A. (1998). "Social capital: its origins and applications in modern sociology." *Annual Review of Sociology* 24: 1-24.
Putnam, R. (2001). *Social Capital: Measurement and Consequences*, Kennedy School of Government, Harvard University.
Reagans, R. and E. Zuckerman (2001). "Networks, diversity, and Productivity: The Social Capital of Corporate R&D Teams." *Organizational Science* 12(4): 502-517.
Reagans, R., E. Zuckerman, et al. (2000). *How to Make the Team: Social Networks vs. Demography as a Criteria for Designing Effective Teams*, Columbia University. 12: 502-517.
Reilly, R. R., J. Chen, et al. (2004). "Power and Empowerment: The Role of Top Management Support and the Team Empowerment in New Product Development." Paper.
Rivera, M. A. (1998). "Second Economy, Second Society, and Political Control in Cuba: Perspectives from Network and Institutional Economics." *Cuba in Transitio*n *8*, Association for the Study of the Cuban Economy, Washington, D.C.
Rivera, M. A. and E. M. Rogers (2004). "Evaluating Public Sector Innovation in Networks: Extending the Reach of the National Cancer Institute's Web-based Health Communication Intervention Research Initiative." *The Innovation Journal: The Public Sector Innovation Journal* 9(3).
Rosenthal, E. (1997). "Social networks and team performance." *Team Performance Management* 3(4): 288.
Sparrowe, R. T., R. C. Liden, et al. (2001). "RESEARCH NOTES - Social Networks and the Performance of Individuals and Groups." *Academy of Management Journal* 44(2): 316.
Stevenson, W. B. (2000). "Agency and social networks: strategies of action in a social structure of position, opposition, and opportunity." *Administrative Science Quarterly* 45(4): 651-78.
Thamhain, H. J. (2003). "Managing innovative R&D teams." R & D Management 33(3): 297-311.
Tidd, J. and K. Bodley (2002). "The influence of project novelty on the new product development process." *R & D Management* 32(2): 127-38.
Tsai, W. and S. Groshal (1998). "Social Capital and Value Creation: The Role of Intrafirm Networks." *Academy of Management Journal* 41(4): 464-175.
Tushman, M. L. and R. Katz (1980). "External Communication and Project Performance: An Investigation into the Role of Gatekeepers." *Management Science* 26(11): 1071-1085.
Wageman, R. (2001). "How Leaders Foster Self-Managing Team Effectiveness: Design Choices versus Hands-on Coaching." *Organization Science* 12(5): 559-557.
West, M. W. and N. R. Anderson (1996). "Innovation in Top Management Teams." *Journal of Applied Psychology* 81(6): 680-693.

APPENDIX A:

Stakeholder Questionnaire *(managers and directors)*

1. Do you remember the Energy Systems LDRD that was developed in the fall of 2003? Y / N; If NO, only answer Q# 7, 13, 14, 18
2. What was your involvement in the development of this project?
3. What do you believe was the purpose of the project?
4. Are you familiar with how it was developed? Y / N
5. Were the goals of the project clearly communicated? Y / N; Why?
6. What was priority of this LDRD compared to other projects you were responsible for at that time? (scale 1-6)
   1 = very low; 6 = very high
   1 2 3 4 5 6 Why?
7. If you were to select someone for a research project, on what basis/criteria would you use and why?
8. During the duration of the project do you think you were sufficiently updated by a team representative as to project status and direction? Y / N; Why? Or why not?
9. After the first (six-month) presentation, was the project progressing according to plan? Y /N Why?
10. During the second phase of the project when the CA site became involved and the project focused on Hydrogen, was the project still progressing according to plan? Y / N Why?
11. During the final phase of the project when the focus was to develop a multi-criteria model, was the project progressing according to plan? Y / N
    Why?
12. How would you rate the overall success of the project? (scale 1 – 6)
    1 = very low; 6 = very high
    1 2 3 4 5 6 Why?
13. How do you feel about the importance of informal social networks regarding work accomplishment? (scale 1 – 6)
    1 = very low; 6 = very high
    1 2 3 4 5 6 Why?
14. To what extent do you use your informal social networks for work-related purposes? (scale 1 – 6)
    1 = very low; 6 = very high
    1 2 3 4 5 6 Why?
15. Do you think networking and the use of social networks was necessary for this project.
    Y / N Why?
16. Could you list three primary issues that you feel influenced the outcome of this project?
    a. :
    b. :
    c. :
17. Could you list three primary benefits that came out of this project?
    a. :
    b. :
    c. :
18. Do you have any suggestions for improving the development of cross functional teams?

Team-Level Questionnaire

1. What is your Formal Educational Training?
2. How many years of professional experience do you possess?
3. How long have you been employed with the lab?
4. How long have you been in your current position?

5. What was your role in the Energy systems LDRD?
6. What do you believe was the purpose of the project?
7. Were you aware of and did you read project documentation?
8. Were goals of project clearly communicated?
9. Did you clearly understand the expected output of the project?
10. How and why were you selected for project (Volunteer? Management-selected?)
11. What technical specialty or skills did you bring to the group?
12. If you were to select someone for a research project, on what basis/criteria would you use and why?
13. How would you rate project leadership? (scale 1 – 6)
    1 = very low; 6 = very high
    1 2 3 4 5 6 Why?

Did you have access to all the necessary resources needed for project? Y / N

14. Do you feel management was supportive in project? (scale 1 – 6)
    1 = very little; 6 = very supportive
    1 2 3 4 5 6 Why?
15. How would you rate your performance based upon Q10 above? (scale 1 – 6)
    1 = very low; 6 = very high
    1 2 3 4 5 6 Why?
16. Were you involved for the entire duration of project? Y / N If NO, explain
17. How frequently did you engage with other members from this LDRD outside the scope of project (i.e. social lunch, casual conversations)? (scale 1 – 6)
    1 = very little; 6 = very frequently
    1 2 3 4 5 6 Why?
18. Did you engage your existing networks to help you complete project tasks? Y / N
19. Did you engage in the development of new networks to help you complete project tasks?
    Y / N Why?
20. To what extent did you go outside your department to seek project specific knowledge and information? (scale 1-6)
    1 = very little; 6 = extensively
    1 2 3 4 5 6 Why?
21. Could you identify at least three people outside project you attempted to gain project related information? Y/ N
22. After the project, are you still maintaining any new connections that were developed? Y/N
23. How would you rate the overall success of this project? (scale 1 – 6)
    1 = unsuccessful; 6 = very successful
    1 2 3 4 5 6 Why?
24. Have you been involved in other multi-disciplinary projects? Y / N
25. How successful were those? (scale 1 – 6)
    1 = unsuccessful; 6= very successful
    1 2 3 4 5 6 Why?

26. Could you list three primary issues that you feel influenced the outcome of this project?
    a. :
    b. :
    c. :
27. Could you list the primary benefits that came out of this project?
    a. :
    b. :
    c. :

Do you have any suggestions for improving the development of cross-functional teams?

APPENDIX B

Supporting results are categorized by organizational then individual factors. Within each factor, descriptive tables for related interview questions are summarized, then supported by content analysis to identify reasons or issues associated with each factor. Closely related tables are given subscripts (e.g., Table 12.1 following related table 12).

Table 9: Factor List

Organizational Factors	*Individual Factors*
Organizational Climate (ORC)	Leadership (LDR)
Managerial Support (MGS)	Roles (RLS)
Empowerment (EMP)	Team Selection (TSL)
Resources (RES)	
Goals (GLS)	

Organizational Factors

Organizational Climate (ORC). Based on interviews, Table 10 indicates that organizational climate was referred to by less than half of the total respondents (40%). Table 10 also shows that organizational climate was referred to more often at the team level (44% Team; 33% MGT).

Table 10; Organizational climate identified by participants

Count of Org Climate	(n=6)	(n=9)	(n=15)
Org Climate	MGT	Team	Grand Total
N	67%	56%	60%
Y	33%	44%	40%
Grand Total	100%	100%	100%

Managerial Support (MGS)

Managerial support was measured at the team level as 'perceived management support' and at the management/stakeholder level through 'project involvement' and 'priority.'

At the team level, Table 11 shows that a majority of the respondents perceived management to be moderately supportive (56%) or unsupportive (22%). However, some of the respondents considered management to be very supportive (22%).

Based on content analysis of the supporting reasons, the most frequently cited issue was the perceived lack of priority for the project demonstrated by management (50%).

Table 11: Team Perception of management support

TQ15 Team Level			Content Analysis (n = 9)	No.	%
MGT Support	Total		Low Priority	3	50%
Low	22%		Lack of Vision, Oversight, Guidance	1	17%
Moderate	56%		Turf Issues	1	17%
Very	22%		Conflicting Objectives	1	17%
Grand Total	100%		Lack of Collaboration	1	17%
			Lack of resources (time)	1	17%

Manager-participants (Table 12) did not view the Energy Systems LDRD as a high priority (50% moderate; 17% low). Only a third considered the project a high priority (33%).

Table 12: Project priority as perceived by management

SQ 5 MGT Priority	(n=6)
Project Priority	Total
Low	17%
Moderate	50%
High	33%
Grand Total	100%

Content analysis revealed that the ‘provision of resources but with no direct involvement’ (50%) was the most frequently cited level of management’s involvement. These resources were either project funds and/or team members. Conversely, a small fraction of participants indicated that they did directly engage as a project sponsor or champion (17%), or provided technical and organizational assistance (33%).

Table 12.1: Management’s level of involvement with project

SQ 2 Management Involvement	(n = 6)	
Project Involvement	No.	%
Project Sponsor/Champion	1	16.7%
Attended project reviews	2	33.3%
Provided resources; no direct involvement	3	50.0%
Managed project	2	33.3%
Provided assistance	2	33.3%

Note: Totals more than 100% due to multiple responses from respondents

Resources (RES)

Resources provided by management were identified as financial contribution to the project, the skills and abilities of the staff provided to the project team (human resources), and the time team members were able to contribute to the project. According to Table 13, more than half (56%) of the team-level respondents believed that management did not provide sufficient resources for the project. Of the respondents that said no, content analysis suggested that a lack of ‘human resources’ (60%) was the most often-cited reason.

Table 13: Team perception of Resources

TQ15 Resources	(n = 9)		Content Analysis (n=5)	No.	%
Resources	Total		Financial resources	1	20%
N	56%		Human resources	3	60%
Y	44%		Time	1	20%
Grand Total	100%		Manager support	1	20%

Note: not equal to 100, since not all respondents provided descriptive information.

Goals (GLS)

Several attributes were used to provide a measure for successful project goals. These attributes, listed in the following tables, identify project purpose, clearly written and communicated project outputs, objectives, and goals, and the participants' understanding of the expected project outputs.

Table 13.1 indicates that a majority of the team level respondents (89%) were aware of and read the project documentation prior to joining the team. Only a small fraction (11%) did not read the documentation because they were not aware of it or they joined the team late in order to replace a colleague from the contributing department.

Table 13.1: Team's awareness of and reading of project documentation

TQ7 Aware of and read documentation	(n = 9)
Project Documentation	Total
N	11%
Y	89%
Grand Total	100%

However, Table 13.2 suggests that a majority of the respondents (78%) did not understand the expected output of the project in any event:

Table 13.2: Team understanding of expected project output

Count of Expected Output	(n=9)
Expected Output	Total
N	78%
Y	22%
Grand Total	100%

In Table 14, the most frequently cited explanation of the project's purpose was to 'Develop a systems analysis group and a new approach' (87%). Promoting cross-functional cooperation (33%) was the second most cited reason regarding project purpose. The table indicates variation within and between team and managerial respondents as to their understanding of project purpose. Three factors associated with project purpose (revive modeling skills, allocate resources for surety, and desire by management) that were identified by the team-level respondents were not identified at the managerial level.

Table 14: Purpose of project variously perceived by team and management respondents

MQ3 & TQ6	Team		MGT		Total	
Project Purpose	No.	%	No.	%	No.	%
Revive modeling skills	1	11%	0	0%	1	7%
Promote cross-functional cooperation	3	33%	2	33%	5	33%
Understand division's ability to conduct systems analyses	1	11%	1	17%	2	13%
Develop a systems analysis group and new approach to analyze energy systems and assist high level decision making	8	89%	5	83%	13	87%
Allocate resources that would increase surety	1	11%	0	0%	1	7%
Desire by management to do systems work	1	11%	0	0%	1	7%

Note: percentages do not equal 100 due to multiple responses from respondents.

According to Table 15, a majority of the total respondents (67%) believed that the project goals were not clearly communicated. The most frequently cited reasons shown in Table 9.4 were that the 'goals were indefinite and unclear' (40%) and the project seemed to 'lack focus' (40%). Furthermore, respondents also commented that there was an overall lack of communication (27%) among project participants and stakeholders.

Table 15: Communication of project goals

TQ8 & MQ4 Goal Communication	LEVEL		
Goal Communication	MGT	TEAM	Grand Total
N	67%	67%	67%
Y	33%	33%	33%
Grand Total	100%	100%	100%

Table 15.1 Issues pertaining to goal communication

Goal communication content analysis	TEAM (n=9)		MGT (n=6)		TOTAL (n=15)	
	No.	%	No.	%	No.	%
Goals indefinite & unclear	5	56%	1	11%	6	40%
Lack of project focus	3	33%	3	33%	6	40%
Overall lack of communication	3	33%	1	11%	4	27%

Note: percentages on content analysis not equal 100 due to multiple responses from respondents.

During the initial six-month review of the project, a majority (67%) of the managerial level participants did not believe that the project was progressing according to plan. Although this number declined by seventeen percent (17%) during the second review of the project (at the end of year 1), a large fraction (50%) of the respondents still did not believe that the project was progressing according to plan. The most frequently cited negative factors (Table 9.6) were a disagreement over, or lack of, project focus (60%) and a lack of communication (40%), leadership (40%), and managerial support (40%). However, these respondents also indicated that during the second (Year 1) review, tangible results were being demonstrated (60%).

By the end of the project, half (50%) of the participants identified in Table 16 believed that the team accomplished the goals of the project. These participants indicated that the team actually demonstrated tangible results in the end (40%). However, a majority of these participants also believed that the results were not completely in line with the specifically-intended goals of the project (60%).

Table 16: Review of project direction by management

MQ8-10 Project direction (n=6)	1st	2nd	Final
MGT reviews	Total	Total	Total
No response	17%	17%	17%
N	67%	50%	33%
Y	17%	33%	50%
Grand Total	100%	100%	100%

Table 16.1: Factors seen as contributing to project direction

Negative Factor (n = 5)	1st	%	2nd	%	Final	%
Project Focus	3	60%	3	60%	0	
Lack of Communication	0		2	40%	1	20%
No Tangible results	1	20%	1	20%	1	20%
Leadership	0		2	40%	0	
MGT support	1	20%	2	40%	0	
Goal incongruence	1	20%	0		3	60%
Positive Factors						
Change ok	1	20%				
Demonstrated results			3	60%	2	40%

Note: percentages from content analysis not equal to 100 due to multiple responses from respondents.

Empowerment (EMP)

Although empowerment is important for a high performance team to be effective, the use of empowerment in this study was one of the least-cited factors in Table 3. However, none of the interview questions specifically discussed the importance of empowerment regarding the success of the project team. During the interview process, only a small fraction (27%) of the respondents identified in Table 10 cited empowerment as an issue.

Table 17: Identification of empowerment by respondents

Empowerment	Team	%	MGT	%	Total	%
Identified	2	22%	2	33%	4	27%
Not identified	7	78%	4	67%	11	73%
Total	9	100%	6	100%	15	100%

Individual Factors: Leadership (LDR)

Project team leadership was recoded from a scale of one (1) through six (6) to a scale of one (1) through three (3): 1-2 = 1; 3-4 = 2; 5-6 = 3; with one (1) meaning low, two (2) meaning average, and three (3) meaning highly successful. Table 18 suggests that a significant majority of team-level respondents who worked under the first project lead did not rate project leadership very highly (average 56%; low 33%). Only a small fraction considered project leadership to be high (11%). Toward the end of the project, when there was a change in leadership, the participants saw an improvement with the new lead, which meant that a significant proportion of participants thus focused rated the project leadership highly (44%). Based upon content analysis, it is evident that participants continued to feel—throughout the project—that a 'Lack of focus' (56%) was the most common issue impacting the project leadership.

Table 18: Perception of project leadership on the part of the two project leaders

TQ13 Project Leadership	(n=9)	
	Project Leader 1	Project Leader 2
Low	33%	11%
Average	56%	44%
High	11%	44%
Grand Total	100%	100%
TQ13 Content Analysis		
Negative Issues	No.	%
Style	3	33%
Control	3	33%
Group consensus	3	33%
Skills & abilities	3	33%
Commitment	1	11%
Lack of Focus	5	56%
MGT involvement	2	22%
Positive Issues		
MGT involvement	1	11%
Skills & abilities	2	22%
Responsiveness	1	11%
Style	1	11%

Roles (RLS)

The influence of individual roles on project team performance was not cited very frequently among the respondents. Among the participants interviewed, Table 19 indicates that a large majority of the managerial respondents (67%) did not play a significant role other than the contribution of resources. Only one member of the management team identified with a champion/sponsor role, while two others simply assisted in managing the project. At the team level, a variety of roles was identified.

Table 19: Identification of project roles by respondent

	Team (n=9)		MGT (n=6)		Total (n=15)	
Role Identification	No.	%	No.	%	No.	%
Modeler	2	22%	0	0%	2	13%
Team Member/ Project lead	2	22%	0	0%	2	13%
Subject matter expert	2	22%	0	0%	2	13%
Could not identify or no significant role	1	11%	4	67%	5	33%
Functional Representative	1	11%	0	0%	1	7%
Project organizer	1	11%	0	0%	1	7%
Process consultant	1	11%	0	0%	1	7%
Champion/ Sponsor	0	0%	1	17%	1	7%
Project manager	0	0%	2	33%	2	13%

Team Selection (TSL)

The importance of team selection refers to a wide range of attributes. Managerial-level respondents rated team selection third (11%) in importance below management support and goals, while team-level respondents rated the importance of team selection fourth (10%) below goals, management support, and leadership. According to Table 20, a majority of the team level participants (67%) was selected by management to participate in the project. Only a third volunteered through self selection (33%).

Table 20: Team selection method

Selection Method	No.	%
Volunteer	3	33%
MGT selected	6	67%
Total	9	100%

A majority of the team level respondents, identified in Table 20.1, had eleven or more years of professional experience (56%, 21 and greater; 22%, 11 to 20 years). However, about half had a shorter tenure with the laboratory (44%, 5 years or less; 11%, 6 to 10 years). Surprisingly, most of the respondents worked within the energy division five years or less (78%).

Table 20.1: Selection Factor: Years of professional experience and tenure in lab and division

	Experience		Tenure		Energy Division	
(n=9)	No.	%	No.	%	No.	%
5 or less	1	11%	4	44%	7	78%
6 to 10	1	11%	1	11%	1	11%
11 to 20	2	22%	3	33%	1	11%
21 and greater	5	56%	1	11%	0	0%
Grand Total	9	100%	9	100%	9	100%

According to Table 20.2, all of the respondents who had less than five years of employment with the laboratory had three or less years of experience in the energy division (100%). Accordingly, more than half of the respondents had three or less years of experience in the energy division (67%).

Table 20.2: Selection Factor: Tenure in laboratory versus tenure in division

Count of Energy Division	Energy Division				
Tenure	11 to 20	3 or less	5 or less	6 to 10	Grand Total
11 to 20	33%	33%	33%	0%	100%
21 or greater	0%	100%	0%	0%	100%
5 or less	0%	100%	0%	0%	100%
6 to 10	0%	0%	0%	100%	100%
Grand Total	11%	67%	11%	11%	100%

Table 20.3 lists attributes considered important by the respondents during the selection of a project team. Diversity in skills and abilities was the most frequently cited attribute (28%). Social and behavioral skills and abilities was the second most frequently cited attribute (22%). Time availability (13%) was the third most cited attribute. However, time availability was cited more frequently by team level respondents (19%) than managerial level respondents (5%). Furthermore, there were some distinct differences between team and managerial level respondents. The 'willingness of employees to leave their pre-existing models and tools at the door when joining a new project team,' was only cited by team-level respondents, while tenure and extant networks were only cited by managerial-level respondents.

Table 20.3: Team selection criteria

Important Aspects of Team Selection	TEAM	%	MGT	%	TOTAL	%
Self selection – volunteer	3	12%	2	10%	5	11%
Tenure		0%	2	10%	2	4%
Diversity in technical skill & abilities	7	27%	6	30%	13	28%
Reputation of previous performance	2	8%	1	5%	3	7%
Social & Behavioral skills & abilities	6	23%	4	20%	10	22%
Coverage, opportunity cost, and funding	1	4%	2	10%	3	7%
Time availability	5	19%	1	5%	6	13%
Network connections, skills & abilities		0%	2	10%	2	4%
Willingness to leave pre-existing models & tools at the door.	2	8%		0%	2	4%
Total	26	100%	20	100%	46	100%